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ENGINEERING DATA

THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

CHAPTER "H"—CONSTRUCTION PLANT

EARTH AND ROCK EXCAVATION  
CANAL


WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS









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Chapter H.

CONSTRUCTION PLANT

(Earth and Rock Excavation - Plant)

Walter J. Francis.







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## Chapter H.

CONSTRUCTION PLANT

Walter J. Francis.

Chapter H, dealing with Construction Plant, is divided into four parts of which this is the third, being a description of the plant devoted to the earth and rock excavation of the Canal. The first part of Chapter H dealt with the construction plant for concrete work; the second part with the plant used in transportation; while the fourth part treats of the construction plant used at the Intake, the Welland River, the Forebay, the Power House and the Tailrace.

CONSTRUCTION PLANT FOR EARTH AND ROCK EXCAVATIONCanal.General.

The excavation of the earth and the rock in the Canal between Montrose and the Forebay at the Screen House constituted the most important single class of work in the whole development, involving as it did the removal of



1. Introduction  
2. Methodology  
3. Results  
4. Discussion

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Page 1 of 1

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about eleven million cubic yards of earth and about four million cubic yards of rock.

All of the earth and rock spoil was removed from the immediate site of the Canal. The greater part of the excavation was made in the dry, but that portion of the Canal lying between Montrose and the control gate was done as sub-aqueous work.

The first shovel, No. 7 (steam), commenced earth excavation at Bowman's Gully on May 10th, 1917, while the canal prism proper was started by shovel No. 3 (electric), on December 10th of the same year. The last shovel, No. 12 (steam), finished and cut out on November 30th, 1921.

The sub-aqueous work of the Canal was commenced by the dredge "Cyclone" on March 14th, 1921, and was completed, about six months later, on September 3rd.

#### The Excavation Plant.

#### The Studies of the Type of Plant to be Used.

The question of the type of plant to be used in connection with the work was the subject of much study on the part of the engineers of the Hydro-Electric Power Commission, and particularly by Mr. Acres and Mr. Goodwin. In his reply to the comprehensive enquiries in regard to the development made by the Honourable Mr. Hearst, Prime Minister of Ontario, on December 12th, 1916,





Mr. W. W. Fope, Secretary of the Commission, made the following statement on January 12th, 1917, with reference to the qualifications and experience of those whom it was proposed to have carry on the construction work;

"The work will be carried out under the direction of the Chief Engineer of the Commission. Mr. Acres, the Hydraulic Engineer of the Commission, under whose direct supervision the scheme has been developed to its present stage, will have responsible charge of the canal construction and the hydraulic portion of the power installation. The immediate supervision of the construction work in the field will be under Mr. J. B. Goodwin, C.E. Mr. Goodwin is a specialist in hydraulic power construction, having had twenty years of experience devoted almost exclusively to this class of work. Mr. Goodwin had charge of the excavation work in the first wheel pit put down by the Niagara Falls Power Company in 1896. He afterwards had charge of the construction of the large tail water tunnel of the Electrical Development Company of Niagara Falls. Since that time he has been in responsible charge of construction on the large plant of the Pennsylvania Water and Light Company at McCall's Ferry, on the plant of the Mount Hood Power Company in the State of Washington, and for the Electric Power Company on the Trent River, besides doing a considerable amount of less important work which nevertheless required engineering ability of a high order.

"For more than two years past Mr. Goodwin has had direct charge in the field of all surveys and other preliminary work in connection with the Queenston Development as well as the inspection and investigation of



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working plans and installations in various parts of Canada and the United States, and the study of working methods as applied to heavy electrically driven construction plant. He will therefore undertake the construction work at Niagara with an intimate knowledge of conditions gained from his experience on the work up to the present time, and with a well developed conception of the difficulties to be encountered and the means to be taken to carry out the work within the estimates and within the time limit.

"Mr. Goodwin will have Mr. G. H. Angell as general superintendent of construction. Mr. Angell now occupies a similar position in connection with the construction of the Kensico Dam for the New York Water Supply System. This work is now practically completed at an actual cost of eight million dollars as against an estimated cost of about ten million dollars. The time allowed to complete the construction of this dam was nine years. Under Mr. Angell's direction the work was actually completed in six years. His professional record is attached hereto and requires no further explanation.

"Both Mr. Goodwin and Mr. Angell are Canadian born and are still Canadian citizens.

"The electric work in connection with the installation will be carried out by the expert electrical engineering staff of the Commission, in conjunction with the specialists on the staffs of the various electrical manufacturing companies."

His statement shows that, in addition to other work, for more than two years Mr. Goodwin had been giving special attention to the study of heavy





electrically-driven construction plant.

In the report of Mr. Acres, known as Report on Project No. 2 (quoted at length in Chapter K), under date of December 26th, 1917, he makes the following statement:

"A careful study of construction methods in connection with the excavation of earth and rock in the Canal was necessary by reason of certain existing conditions which would have a vital influence upon excavation cost. These conditions were, first, the availability of cheap electric power for operating construction plant; second, the large quantities of earth and rock to be removed, which made it possible to consider the use of excavating machinery of the heaviest type and largest capacity obtainable; and, third, the unusually good facilities available for the disposal of spoil, within short hauling distance, along the crest of the Niagara escarpment.

"Having the above conditions in mind, the Commission's Engineers spent several months in collecting and studying data in connection with the type of construction plant required. The operation of electric and steam driven excavating machinery was witnessed and studied in various parts of Canada and the United States and a large amount of information with reference to output, operating cost, working conditions, etc. was obtained and carefully analyzed.

"The result of this investigation was, that in January, 1917, when market conditions indicated that any further delay in the purchase of the plant would result in prohibitive prices and practically impossible



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delivery dates, the Commission's Engineers were immediately able to recommend for purchase the type of plant best suited for carrying on the projected work.

"Practically all of the plant so purchased is now on the ground and a portion of it is in actual operation."

The engineers of the Hydro-Electric Power Commission decided that the excavation of the dry material in the Canal could best be done by specially built electrically-driven shovels, aided by a number of shovels of the ordinary size and type. Following the removal of the overburden of earth, the rock excavation was to be done by the same shovel plant. It was decided that the sides of the rock canal were to be cut down by channelling machines, and the body of the rock was to be drilled and blasted.

The earth and rock spoil were to be removed by means of a specially constructed railway system, already described in the second part of this Chapter under the head of "Transportation".

The sub-aqueous work was to be done by dredging.

As a result of the adoption of this general programme, the engineers of the Hydro-Electric Power Commission purchased from time to time a total of thirteen shovels, six of which were driven by steam and seven by electric energy, the bucket capacity varying between  $7/8$  of a cubic yard and 8 cubic yards. They also purchased twenty channellers, forty-four marine drills, sixty-three tripod drills, fifteen drifters, ninety hammer drills and one well drill, together with all the necessary accessories therefor.



The first of the three main parts of the book is devoted to a general survey of the history of the world from the beginning of the world to the present time. The second part is devoted to a detailed account of the history of the world from the beginning of the world to the present time. The third part is devoted to a detailed account of the history of the world from the beginning of the world to the present time.

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The second part of the book is devoted to a detailed account of the history of the world from the beginning of the world to the present time. The third part is devoted to a detailed account of the history of the world from the beginning of the world to the present time.

The third part of the book is devoted to a detailed account of the history of the world from the beginning of the world to the present time. The fourth part is devoted to a detailed account of the history of the world from the beginning of the world to the present time.

In connection with the sub-aqueous work the necessary plant was rented.

List of Principal Items of Excavation Plant for Canal.

The following tables give the principal items of excavation plant used for the Canal, together with dates of purchase and the cost.

List of Shovels

Unit No.	Motive Power	Weight in Tons	Bucket Capacity in Cu.Yds.	Make	Model Number	Date of Purchase	Cost
1	Electric	332	.... 8	Bucyrus	225-B	March 28, 1917	.. \$88,000
2	Electric	332	.... 8	Bucyrus	225-B	March 28, 1917	.. 88,000
3	Electric	118	.... 4	Bucyrus	103-C	March 28, 1917	.. 43,865
4	Electric	118	.... 4	Bucyrus	103-C	March 28, 1917	.. 43,865
5	Steam	30	... 7/8	Bucyrus	18-B	March 28, 1917	.. 10,805
6	Electric	30	... 7/8	Bucyrus	18-B	March 28, 1917	.. 15,732
7	Steam	65	.... 2 1/2	Bucyrus	45	Sept. 13, 1917	.. 9,000
8	Electric	332	.... 8	Bucyrus	225-B	July 6, 1918	.. 152,000
9	Electric	118	.... 4 1/2	Bucyrus	103-C	July 6, 1918	.. 73,785
10	Steam	35	.... 1 1/2	Bucyrus	35-B	May 10, 1919	.. 23,750
11	Steam	275	.... 8	Marion	300	July 12, 1920	.. 142,350
12	Steam	332	.... 8	Bucyrus	225-B	Aug. 14, 1920	.. 138,072
13	Ditcher	12	.... 1	Keystone	4	Oct. 14, 1919	.. 5,990
14	Steam	83	.... 2 1/2	Marion	60	Nov. 1, 1920	.. 17,128

List of Other Excavating Plant

2	Jordan Spreaders, 100,000 lbs. capacity, with equipment
1	Bucyrus Spreader, 142,320 lbs. capacity, with equipment
1	Jordan Spreader, 80,000 lbs. capacity, with equipment
20	Sullivan Channellers
44	Marine Drills
63	Tripod Drills
15	Drifter Drills
90	Hammer Drills
1	Well Drill



1. The following table shows the results of the survey conducted in the year 2022. The data is presented in the form of a table with 10 columns and 10 rows. The first column represents the 'Year' and the subsequent columns represent the 'Month' (January to December). The 'Total' column shows the sum of the values for each year.

2. The data is as follows:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2022	100	120	150	180	200	220	250	280	300	320	350	380	2500
2021	80	100	120	140	160	180	200	220	240	260	280	300	2000
2020	60	80	100	120	140	160	180	200	220	240	260	280	1600
2019	40	60	80	100	120	140	160	180	200	220	240	260	1200
2018	20	40	60	80	100	120	140	160	180	200	220	240	800
2017	10	20	40	60	80	100	120	140	160	180	200	220	400
2016	5	10	20	40	60	80	100	120	140	160	180	200	200
2015	2	5	10	20	40	60	80	100	120	140	160	180	100
2014	1	2	5	10	20	40	60	80	100	120	140	160	50
2013	0	1	2	5	10	20	40	60	80	100	120	140	25

### Summary of the Survey Results

The survey results show a steady increase in the values over the years. The total value for the year 2022 is 2500, which is the highest value recorded. The values for the year 2013 are the lowest, with a total of 25. The data indicates a consistent growth trend over the period covered by the survey.

The following table shows the percentage increase in the values for each year compared to the previous year:

Year	Percentage Increase
2022	25%
2021	20%
2020	15%
2019	10%
2018	5%
2017	2%
2016	1%
2015	0.5%
2014	0.2%
2013	0.1%

Typical Photographs of Excavation Equipment.

Photograph No. H-51, included herewith as page H-101, shows one of the large electric shovels, shovel No. 1, in operation at Station 346+81, in August, 1913. The shovel is in the act of loading a car at a high elevation. The site is in the Canal cut on the northerly side of Bowman's Gully, stated by geologists to have been one of the buried channels of the Niagara River in past ages. In passing it is interesting to note the stratification exposed by the shovel which is working, the work track of which is about 70 feet below the natural surface on which the growing vegetation may be observed.

Photograph No. H-52, **COPY** being the lower photograph on the page just mentioned shows one of the large steam shovels, shovel No. 11, loading earth into a car at a high elevation.

Photograph No. H-53, being the upper picture on page H-102 hereof, shows shovel No. 7, one of the smaller steam shovels, excavating earth about Station 14 in the immediate vicinity of Montrose, working out a shallow cut and loading the frozen earth into a dump car.

The lower photograph, No. H-54, on the last mentioned page, shows shovel No. 3, one of the medium size electric shovels, starting a cut on the surface near Montrose. This picture illustrates clearly a typical medium size electric shovel.

The upper photograph, No. H-55 on page H-103 hereof, shows a view of shovel No. 9 breaking the ground near Montrose, working in earth. This shovel is typical of one of the medium size electric shovels.

The lower photograph, No. H-56 on the last mentioned page, shows the upper





part of shovel No. 12, which is one of the large steam shovels, carrying through a 15-foot earth cut in the vicinity of Lundy's Lane.

The upper photograph, No. H-57 on page H-104 hereof, shows shovel No. 4 on its arrival in 1917 ready for work. This shovel is the same as Nos. 3 and 9.

The lower photograph, No. H-58, on the last mentioned page, shows shovel No. 1, the first of the large electric shovels, commencing the earth cut working northwards from the edge of Bowman's Gully. This photograph, which shows the turntable of the shovel, and photograph No. H-51 on page H-101 give a comprehensive idea of the construction of shovels Nos. 1, 2 and 8.

Photograph No. H-59, the upper picture on page H-105 hereof, shows a group of channelling machines at work on the rock surface. Cutting tools are lying in the foreground.

The lower picture on the same page, No. H-60, shows the Keystone ditcher digging a drainage ditch.

The two photographs, being Nos. H-61 and H-62 on page H-106 hereof, give two views of batteries of marine drills. In the upper picture a battery of eight is shown working in the Canal near the Forebay, while the lower shows a battery of thirteen marine drills in the cut near Lundy's Lane.

The upper picture, No. H-63 on page H-107, shows a Jordan spreader as used to distribute the earth on the disposal areas.

The lower picture, No. H-64 on the last mentioned page, shows a Bucyrus spreader widening out the dump on the main disposal area.







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To face page H-101

No. H-51

Photograph showing

Large Electric Shovel, No. 1. Excavating near Bowman's Gully.

Taken August 7th, 1918.

COPY

No. H-52

Photograph showing

Large Steam Shovel, No. 11. Excavating at Station 139.

Taken December 4th, 1920.











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To face page H-102

No. H-53

Photograph showing

Steam Shovel, No. 7, Excavating at Station 14.

Taken February 6th, 1920.

COPY

No. H-54

Photograph showing

Electric Shovel, No. 3, Breaking Ground at Station 142.

Taken May 6th, 1920.







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No. H-55

Photograph showing

Electric Shovel, No. 9, Breaking Ground near Montrose.

Taken April 6th, 1920.

COPY

No. H-56

Photograph showing

Large Steam Shovel, No. 12, Excavating near Landys Lane.

Taken March 3rd, 1921.









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To face page H-104

No. H-57

Photograph showing

Electric Shovel, No. 4. Ready to Work.

Taken December 12th, 1917.

COPY

No. H-58

Photograph showing

Large Electric Shovel, No. 1. Demolishing at Station 349.

Taken May 18th, 1918.







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To face page H-105

No. H-59

Photograph showing

Group of Sullivan Channellers.

Taken August 7th, 1919.

COPY

No. H-60

Photograph showing

Ditching Machine, No. 13, Digging at Station 73.

Taken February 6th, 1920.







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To face page H-106

No. H-61

Photograph showing

Battery of Marine Drills Working at Station 443.

Taken December 4th, 1919.

COPY

No. H-62

Photograph showing

Battery of Marine Drills Working at Lundys Lane.

Taken May 4th, 1921.







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To face page H-107

No. H-63

Photograph showing  
Jordan Spreader No. 1.

Taken November 7th, 1919.

COPY

No. H-64

Photograph showing  
Bucyrus Spreader Working on Main Disposal Area.

Taken January 7th, 1921.







General Dimensions of the Large Shovels.

In the latter part of the year 1916 the engineers of the Hydro-Electric Power Commission decided to utilize the largest shovels developed up to that time, for the reasons already set forth in Chapter G, page G-12, and in January, 1917, the necessary authority was given to purchase.

The first three large shovels purchased are known as 225-B revolving Bucyrus shovel equipped with an 80-foot boom and a 58-foot dipper stick for normal operations, and having a 90-foot boom for exceptionally high lifts. The weight of each shovel is 332 tons. Under normal conditions a 5-cubic yard dipper is used for rock excavation, and an 8-cubic yard dipper for earth. Equipped with the auxiliary parts these shovels can load cars standing on a track 70 feet above the track of the shovel, dig a cut with a bottom width of 120 feet, and load cars at the above height 88 feet sideways from the centre of the shovel. The motor equipment per shovel consists of two 162-horse-power hoist motors, one 122-horse-power swing motor, one 122-horse-power crowding motor, and one 10-horse-power compressor motor, a total rated motor capacity of 578 horse-power. Each shovel carries its own transformers which step down from the secondary feeder voltage of 4,000 to the motor voltage of 440.

The large shovels are mounted on two parallel tracks each of 36-inch gauge, the distance from centre to centre of tracks being 30 feet.

The working capacity of each of the shovels as given by the manufacturers is 5,000 cubic yards of earth or 3,000 cubic yards of rock per day of ten hours.

Two of these shovels, being Nos. 1 and 2, were ordered on March 28th, 1917, at a cost of \$38,000 each at Niagara Falls, Ontario. The third shovel, No. 3,





was ordered on July 6th, 1918, at a cost of \$152,000 delivered.

As the work progressed, the engineers of the Hydro-Electric Power Commission decided to purchase two additional large shovels, but it was impossible to procure others of the same type. In July, 1920, however, they ordered a large Marion steam shovel, No. 11, being type No. 300, weighing 275 tons, and having other characteristics comparable with shovels Nos. 1, 2 and 8. On August 14th, 1920, they purchased a Bucyrus steam shovel, No. 12, similar in all respects to Nos. 1, 2 and 8, excepting that the motive power was steam.

#### Other Shovels.

COPY

The shovels Nos. 3, 4 and 9 were next in size to the largest. They were Bucyrus, Model 103-C, weighing 118 tons, equipped with a  $3\frac{1}{2}$ -cubic yard bucket for rock, and a  $4\frac{1}{2}$ -cubic yard bucket for earth, all electrically driven.

The capacity of these shovels as given by the makers is 3,500 cubic yards of earth or 2,000 cubic yards of rock per day of ten hours. Shovels Nos. 3 and 4 were ordered on March 28th, 1917, and cost \$43,865 each at Niagara Falls. No. 9 was ordered on July 6th, 1918, and cost \$73,785 at the same place.

Two of the shovels, Nos. 7 and 14, were steam shovels with a bucket capacity of  $2\frac{1}{2}$  cubic yards, the former being a Bucyrus shovel, Model 45, and the latter a Marion shovel, Model 60.

All the other shovels were smaller in size. Unit No. 13 in the table on page H-98 hereof is not a steam shovel but a small special machine used for ditching purposes. It is included in the table for the sake of completeness.

The first part of the report is a summary of the work done during the year.

The second part of the report is a detailed account of the work done during the year.

The third part of the report is a summary of the work done during the year.

The fourth part of the report is a detailed account of the work done during the year.

The fifth part of the report is a summary of the work done during the year.

The sixth part of the report is a detailed account of the work done during the year.

The seventh part of the report is a summary of the work done during the year.

The eighth part of the report is a detailed account of the work done during the year.

The ninth part of the report is a summary of the work done during the year.

The tenth part of the report is a detailed account of the work done during the year.

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The eighth part of the report is a detailed account of the work done during the year.

The ninth part of the report is a summary of the work done during the year.

The tenth part of the report is a detailed account of the work done during the year.

The eleventh part of the report is a summary of the work done during the year.

The twelfth part of the report is a detailed account of the work done during the year.

The thirteenth part of the report is a summary of the work done during the year.

The fourteenth part of the report is a detailed account of the work done during the year.

The fifteenth part of the report is a summary of the work done during the year.



Dry Excavation Methods.

The general methods of handling the earth and rock excavation in the dry are comprehensively shown in a series of thirteen photographs Nos. H-65 to H-77 included herewith as pages H-114 to H-120 inclusive. The work of individual machines is shown to some extent in the series of photographs Nos. 51 to 64.

The earth overburden at the peak of the Canal cut near Lundys Lane was largely removed by the use of ordinary steam shovels in the usual way. The complete operations are shown in photograph No. H-65 on page H-114 hereof. The lifts were taken down in about 12-foot faces by this method, the service track for the spoil train being on the same general level as the service track of the shovel. Generally speaking, the shovels followed one another in order until the natural rock surface was uncovered. The large shovels were also used in this work, being put into commission on arrival, and generally speaking they worked on a face of 30 to 40 feet. On the northerly side of Bowman's Gully, shovel No. 1 worked against a face of over 80 feet in some cases.

After the removal of the earth overburden, the rock sides of the Canal were cut down with channellers to a depth of approximately 10 feet, and the body of the rock excavation was drilled with tripod drills or with marine drills according to the type of shovel to be subsequently used in the excavation, the tripod drills being used for the smaller shovels in shallow faces, and the marine drills where one of the five large shovels was to follow. Photograph No. H-66 shows the rock blasted in the vicinity of the Niagara, St. Catharines & Toronto Railway bridge ready for the shovel excavation. Photograph No. H-67



CONFIDENTIAL

The purpose of this report is to provide a summary of the results of the investigation conducted by the Department of Defense, Office of the Inspector General, in response to the request for information from the House of Representatives, Committee on Armed and Naval Services, regarding the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

The report covers the period from January 1, 1961, to December 31, 1961, and is organized into three main sections: (1) a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment; (2) a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment; and (3) a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

COPY

The first section of the report describes the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment. It includes a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment, and a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

The second section of the report describes the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment. It includes a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment, and a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

The third section of the report describes the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment. It includes a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment, and a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

The fourth section of the report describes the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment. It includes a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment, and a description of the activities of the Central Intelligence Agency, Office of the Inspector General, in the area of the procurement of military equipment.

shows the result of blasting during 1919 near the Stanley Street diversion. The service track for the construction railway was laid close to the channelled out and the shovels loaded directly into the train. These operations are clearly shown on photographs Nos. H-69 and H-70. The former photograph is a view of the work looking south from the Thorold Road temporary bridge, with shovel No. 2 working in the second bench in the middle distance, the first bench having already been excavated by shovel No. 4. Photograph No. H-70 shows shovel No. 9 excavating the first bench, near Victoria Street crossing, and loading the rock spoil into a standard electrically-hauled spoil train. This bench had a 10-foot face. The channelled surface may be clearly seen, and in the left foreground a quantity of spoil for lining the bank may be seen in place.

Photograph No. H-71 shows shovels 8 and 9 excavating the rock at Lundys Lane cut. The tripod drills are working in the foreground on the original rock surface. Blasted rock spoil is seen in the rear of the drills and on this spoil shovels No. 8 and No. 9 are working, No. 8 in advance of No. 9, No. 8 working on about a 20-foot face and No. 9 on about a 10-foot face. In this picture may be seen also the rock spoil used for lining the banks. In the distance the frames of a battery of marine drills are dimly outlined. Photograph No. H-72 was taken the same day as photograph No. H-71 looking in the opposite direction. In the immediate foreground shovel No. 8 is seen working on a 20-foot face. In advance of No. 8 may be seen the large Bucyrus steam shovel No. 12, cleaning up the earth slope on which the rock spoil is being deposited by a dirt train. Between the shovels are seen a battery of tripod drills and a battery of





channelling machines. In the far distance may be seen the frames of the marine drills. The two pictures, Nos. H-71 and H-72, show progressive rock work from marine drills on one bench to marine drills on the next with three shovels working progressively between them.

Photograph No. H-73 shows the progress in the rock in the Canal in August, 1920, at about Station 400, midway between Bowman's Gully and the Forebay. At this location the earth overburden is only 6 or 8 feet in depth. The first lift has been taken out and the channel cut of the side wall about 10 feet deep may be clearly seen. The rock in the Canal has been drilled by marine drills and the holes are being loaded with dynamite and the tamping rods may be seen in the foreground. In the background the dipper and the top of the boom of shovel No. 1, one of the large electric shovels, may be seen in the act of loading rock spoil into an electrically-hauled spoil train. In this case shovel No. 1 is working on a face of about 42 feet, with a 55-foot difference in elevation between shovel and loading tracks.

Photograph No. H-74 shows No. 2, the second of the large electric shovels, working southerly below the curve on the southerly side of the Portage Road on a working face of 30 feet, being the second bench in rock at this point. The shovel is in the act of loading a train. The channelled surface of the first bench may be clearly seen in the picture. The rock spoil has been deposited on the easterly or left-hand slope in the picture, while the placing of the spoil on the westerly or right-hand slope of the picture is still uncompleted. This rock spoil for protection lining was always deposited from the dump cars on the rip-rap track on the top of the slope. In the distance may be seen a battery

The first part of the document discusses the importance of maintaining accurate records. It emphasizes that proper record-keeping is essential for ensuring the integrity and reliability of the data collected. This section also outlines the various methods used to collect and analyze the data, highlighting the challenges faced during the process.

In the second part, the focus shifts to the results of the study. The findings indicate that there is a significant correlation between the variables studied, which supports the hypothesis. The data shows that as the independent variable increases, the dependent variable also tends to increase.

The third part of the document provides a detailed analysis of the data. It includes several tables and graphs that illustrate the trends and patterns observed. The analysis shows that the data is consistent with the theoretical model, suggesting that the model is a good representation of the underlying process. The results also highlight the need for further research to explore the underlying mechanisms.

The fourth part of the document discusses the implications of the findings. It suggests that the results have important implications for the field of study, particularly in understanding the relationship between the variables. The findings also provide valuable insights into the practical applications of the research, which can be used to inform policy and practice.

The final part of the document concludes the study. It summarizes the key findings and reiterates the importance of the research. The conclusion states that the study has successfully demonstrated the relationship between the variables and has provided a solid foundation for future research. The authors express their gratitude to the funding agencies and the participants who made the study possible.



of marine drills in operation.

Photographs Nos. H-75 and H-76 are included to show in detail the class of rock spoil handled by the shovels. Both of these pictures were taken at Lundy's Lane disposal area and are typical also of the character of excavated rock which was taken to the crushing plant to be prepared for concrete aggregate.

Photograph No. H-77 shows a picture of the rock excavation near the entrance to the Forebay, and is intended to illustrate the character of the excavated rock surface north of the Whirlpool, the lower 20 feet of the exposed face being shale and the upper portion limestone. Only one bench of channel cut was made, the rest of the rock face being formed by careful drilling and shooting as the lifts were carried downwards. It had been originally intended to leave the wall of the Canal unlined, but in order to increase the carrying capacity of the Canal it was decided to line the walls and floor with concrete, and thereby lessen the frictional resistance of the flowing water. Before the placing of the concrete, the walls were scaled down with hand tools.

#### Drilling.

As has already been stated, the drilling was done with standard tripod drills or with marine drills according to the depth of holes required. The drills were all driven by compressed air supplied from electrically-driven compressors in two principal stations, one of which was at Montrose and the other at the Whirlpool yards, and the air was delivered to the drills at a pressure of about 90 pounds per square inch, and for better efficiency was







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To face page H-114

No. H-66

Photograph showing

Blasted Rock Spoil Ready for Shovel  
near Niagara, St. Catharines & Toronto Railway Bridge.

Taken August 6th, 1920.

COPY

No. H-65

Photograph showing

Earth Excavation Methods at Landys Lane.

Taken December 2nd, 1920.











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To face page H-115

No. H-67

Photograph showing

Blasted Rock Spoil Ready for Shovel at Station 298.

Taken August 7th, 1919.

COPY

No. H-68

Photograph showing

Excavation Methods Adjacent to Bowman's Gully.

Taken February 3rd, 1920.









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To face page H-116

No. H-69

Photograph showing

Canal Excavation Work.

looking south from Thorold Road Temporary Bridge.

Taken October 1st, 1919.

COPY

No. H-70

Photograph showing

Canal Excavation Work at Station 225.

Taken December, 1920.









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To face page H-117

No. H-71

Photograph showing

Canal Excavation Work at Station 153.

Taken May 4th, 1921.

COPY

No. H-72

Photograph showing

Canal Excavation Work at Station 153.

Taken May 4th, 1921.











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To face page H-118

No. H-73

Photograph showing

Loading the Drill Holes with Dynamite at Station 400.

Taken August 7th, 1920.

COPY

No. H-74

Photograph showing

Canal Excavation Work on Southerly Side of Tortage Road.

Taken February 3rd, 1921.









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To face page H-119

No. H-75

Photograph showing

Typical Rock Spoil on Edge of Lundys Lane Disposal Area.

Taken October 11th, 1922.

C O P Y

No. H-76

Photograph showing

Typical Rock Spoil on Top of Lundys Lane Disposal Area.

Taken October 11th, 1922.









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COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

To face page H-120

No. H-77

Photograph showing

COPY

Typical Finished Rock Excavation of Canal at Station 443.

Taken June 1st, 1920.







re-heated back of the hose connections.

The compressor plants had a capacity of 26,000 cubic feet of air per minute at a pressure varying from 110 to 125 pounds per square inch in the compressor plants. The air main was located on the westerly side of the Canal on the ground surface, and was made of flexible-coupled wrought-iron pipe in a single line varying from 10" to 8" diameter, fitted with a liberal number of off-takes.

The steel for the tripod drills was usually 1-3/8 inches in diameter. The marine drills used 2-inch steel, and gave a hole bottoming 2 1/2 inches or more in diameter at 60-foot depth. The maximum depth of holes drilled by the marine drills was ordinarily sixty feet. The maximum number of marine drills in use at one time was thirty-eight and of tripod drills sixty.

The sides of the cutting were close-drilled for the second and the subsequent benches. When marine drills were used with a depth of sixty feet the close-drilling holes were at two-foot centres, while for tripod drills in fifteen-foot holes or less the close-drilling holes were at six-inch centres. In the body of the excavation the drilling was generally at seven-foot centres for the marine drills, and at six-foot centres for the tripod drills.

The diagrams included herewith as page H-122 show the amount of drilling done and the progress thereof. The total drilling in the Canal work was 2,554,491 lineal feet.

#### Blasting.

The blasting on the work was practically all done with 60 per cent.



no-headed back of the nose contractions.

The compressor flange had a capacity of 10,000 cubic feet of air per minute at a pressure varying from 110 to 120 pounds per square inch in the compressor flange. The air main was located on the western side of the Canal on the ground surface, and was made of flexible-coupled wrought-iron pipe in a straight line varying from 10" to 24" diameter, fitted with a liberal number of elbows.

The steel for the tripod drill was usually 1-3/4" inches in diameter. The rotating drill head 2-inch steel, and gave a hole bottoming 24 inches or more in diameter at 4-foot depth. The maximum depth of holes drilled by the rotating drill was ordinarily 10 feet. The maximum number of rotating drills in use at one time was thirty-eight and of tripod drill six.

The kind of air used was also drilled for the ground and the water. When rotating drills were used with a depth of about 10 feet the disc-drilling holes were of two-foot diameter, while for tripod drills in fifteen-foot holes or less the disc-drilling holes were of six-inch diameter. In the body of the excavation the drilling was generally at seven-foot centers for the rotating drills, and at six-foot centers for the tripod drills.

The diagrams included herewith as page H-122 show the amount of drilling done and the progress thereof. The total drilling in the Canal work was

The blasting on the work was practically all done with 60 per cent.







dynamite, but 40 per cent. was sometimes employed. In all 2,880 tons were used, being an average of 1.20 pounds per cubic yard of solid rock excavated.

It was the practice to spring the deep holes three times before finally loading them, and to fire the close-drilling holes by delayed timing. The loading varied according to the stratification of the rock. For the springing shots the charge varied from one-half to one and one-half cases of dynamite, and the deep holes were finally loaded with about six cases each.

#### Channelling.

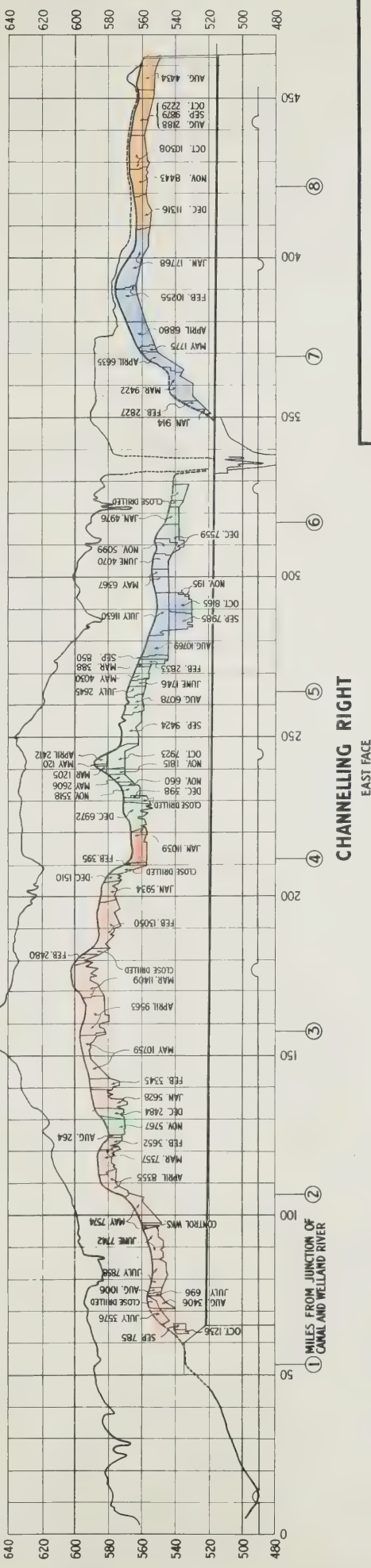
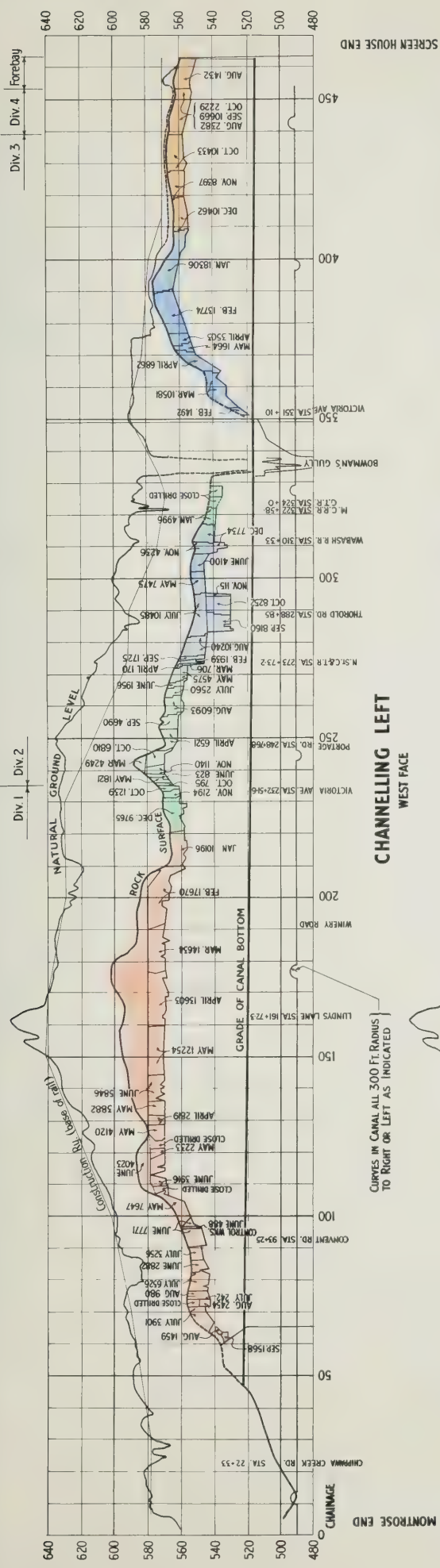
The channelling machines were operated from the same compressed air service as the drills. The maximum number of channelling machines in use at any time was nineteen, all of standard Sullivan make. It had been originally intended to channel the whole of the side faces of the Canal, but the subsequent decision to line the rock section rendered channelling unnecessary beyond the depth of the first bench. The diagrams included herewith as page H-124 show the amount of channelling done and the progress thereon. The total surface area of channelling in the Canal work was 716,475 square feet.

#### Excavation Progress.

The two charts shown on page H-125 hereof show the percentage progress of earth and rock excavation month by month throughout the continuance of the work, while the chart included as page H-126 hereof shows the total quantity excavated month by month, accounting for the removal of 10,907,625 cubic yards of earth,







**HYDRO-ELECTRIC INQUIRY COMMISSION**  
**W. D. GREGORY - CHAIRMAN**  
**QUEENSTON-CHIPPAWA POWER DEVELOPMENT**

# PROGRESS PROFILE CHANNELLING

Toronto, March 10th., 1923. Made by *SRW*, Checked by *LLH*  
**WALTER J. FRANCIS, C.E.**  
CONSULTING ENGINEER

**NOTE: CHANNELLING SHOWN IN SQUARE FEET**

**LEGEND**

Year	Color
1918	Orange
1919	Yellow
1920	Green
1921	Red

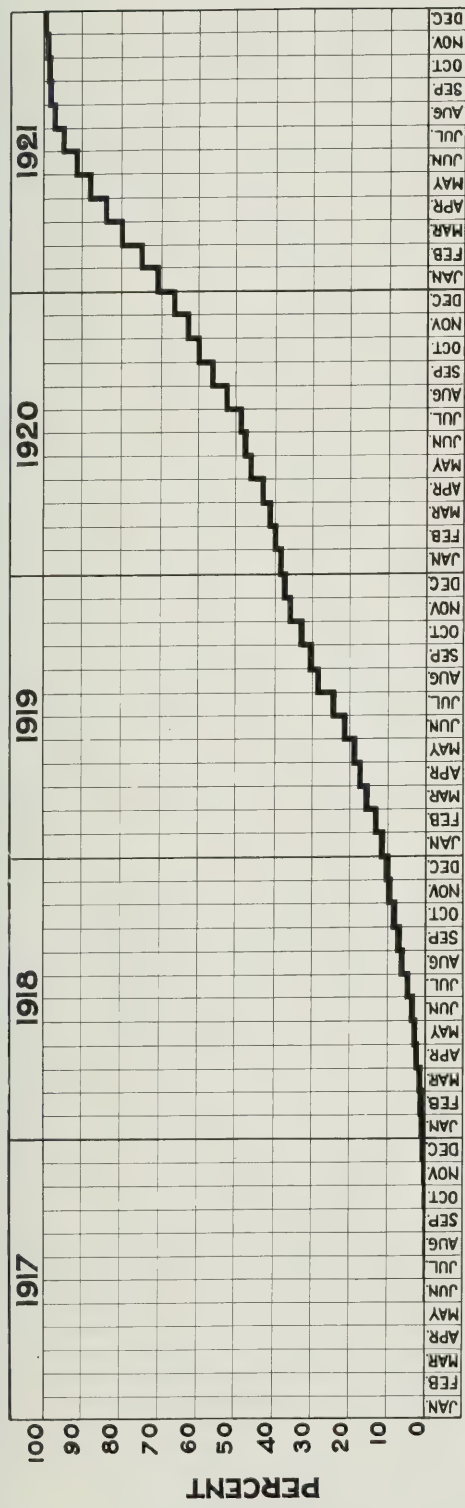
**SCALE OF FEET**

**HORIZONTAL**  
0 1000 2000 3000 4000 5000

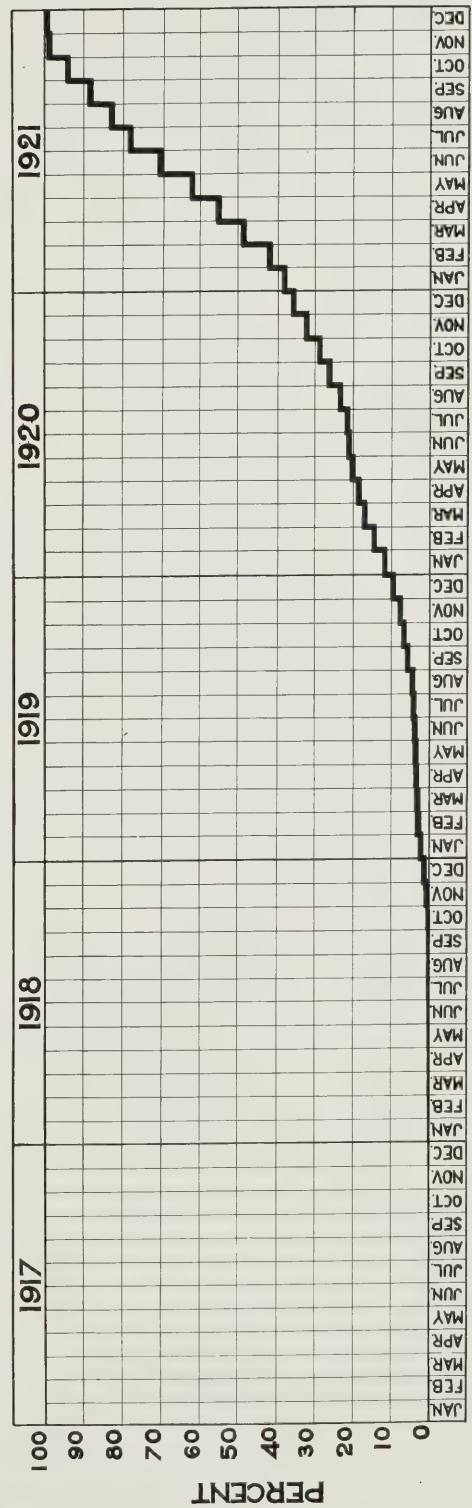
**VERTICAL**  
0 20 40 60 80 100







EARTH EXCAVATION

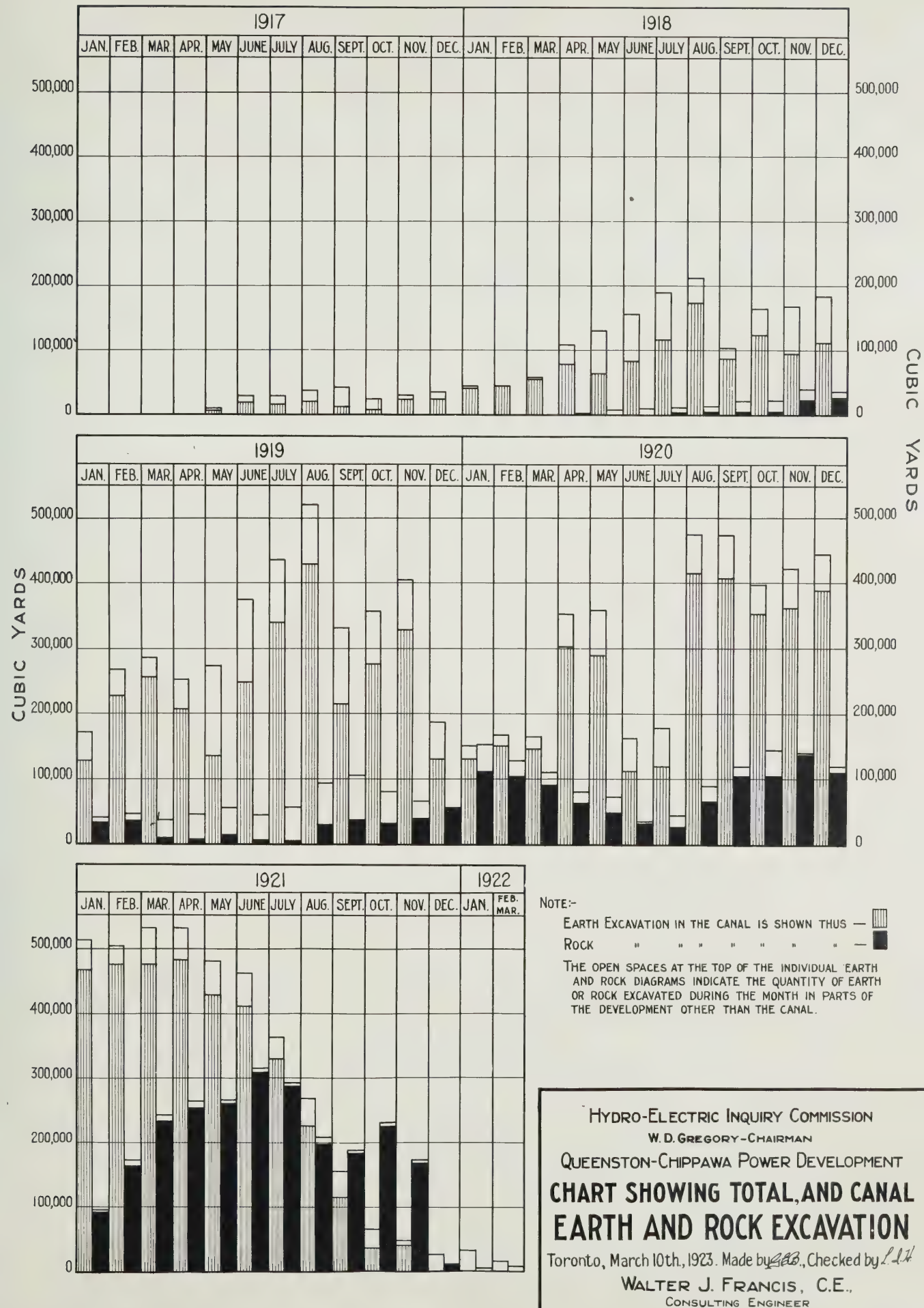


ROCK EXCAVATION

HYDRO-ELECTRIC INQUIRY COMMISSION  
W.D. GREGORY - CHAIRMAN  
QUEENSTON-CHIPPAWA POWER DEVELOPMENT  
**PERCENTAGE PROGRESS CHARTS**  
**EARTH AND ROCK EXCAVATION**  
Toronto, March 10th, 1923. Made by *WJ* Checked by *WJ*  
**WALTER J. FRANCIS, C.E.,**  
CONSULTING ENGINEER









and 3,840,378 cubic yards of rock.

The chart included herewith as page H-128 gives the average number of trains per day required to transfer the material to the main disposal areas, and to the crushers and the rip-rap work. This chart was plotted from voluminous train records made during the construction period. The two pages included herewith as H-129 and H-130 give the same information in figures.

The ten pages included herewith as H-131 to H-140, inclusive, show progressively the location and operation of each of the excavation units month by month, being a graphic supplement to the information given on pages H-141 to H-146 inclusive.

## COPY

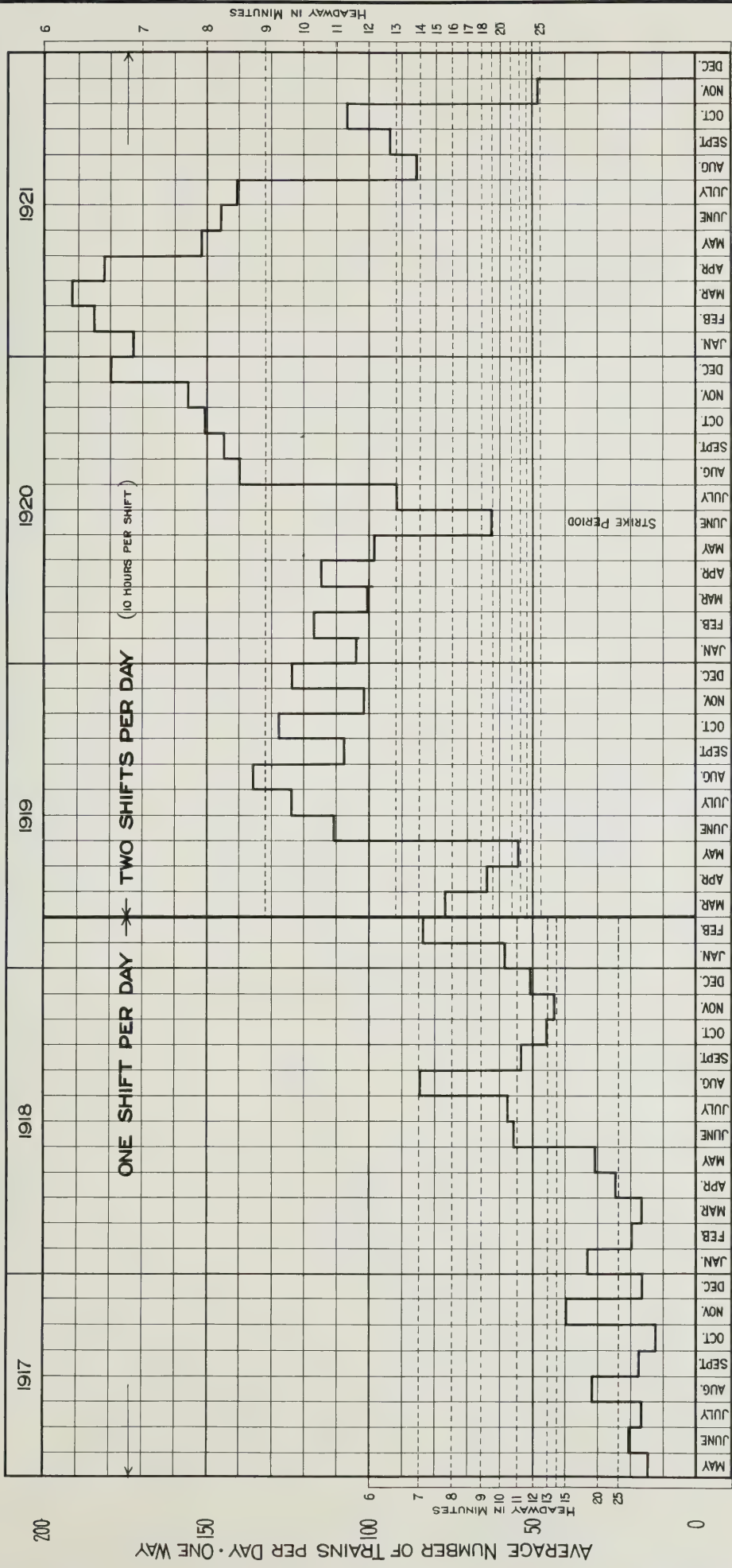
### Unwatering.

The unwatering for the excavation work of the canal was accomplished by the digging of side ditches for the disposal of the surface water, and later by pilot shovel cuts down to the rock surface into which sump holes were made. The sumps were pumped out by means of electrically-driven centrifugal pumps in some cases, while in others duplex steam pumps were used with compressed air as the motive power.

In the work at Bowman's Gully the unwatering was done by means of a centrifugal pump mounted on a scow so that the variations in the water level could be followed by the pump without disturbing its setting.







NOTE:-  
 THE DOTTED HORIZONTAL LINES DENOTE  
 INTERVALS BETWEEN TRAINS, IN MINUTES.

HYDRO-ELECTRIC INQUIRY COMMISSION  
 W. D. GREGORY - CHAIRMAN  
 QUEENSTON-CHIPPAWA POWER DEVELOPMENT

# TRAINS TO DISPOSAL AREAS

## AVERAGE NUMBER PER DAY, BY MONTHS

Toronto, March 10th., 1923. Made by *gbb* Checked by *L.H.*

WALTER J. FRANCIS, C.E.,  
 CONSULTING ENGINEER





1. The purpose of this document is to provide information regarding the status of the project.

2. The project is currently in the planning stage and is expected to be completed by the end of the year.

3. The project is currently in the planning stage and is expected to be completed by the end of the year.

4. The project is currently in the planning stage and is expected to be completed by the end of the year.

5. The project is currently in the planning stage and is expected to be completed by the end of the year.

Queenston-Chippawa Power DevelopmentTable showing Daily Train Movement, one way.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	S.S. #5	E.S. #6	S.S. #7	E.S. #8
<u>1917:</u>								
May .....							192	
June .....							503	
July .....							426	
August .....					453		328	
September .....					208		69	
October .....					131		55	
November .....					514	369	147	
December .....			116		-	189	86	
Totals			116		1,306	558	1,806	

<u>1918:</u>								
January .....			207	86	221	311	-	
February .....			154	79	-	196	-	
March .....	102		250	91	-	-	-	
April .....	371		55	121	-	101	-	
May .....	557	73	-	102	-	120	-	
June .....	397	105	49	191	615	142	-	
July .....	634	-	157	115	426	177	-	
August .....	888	339	132	35	760	114	30	
September .....	36	436	181	231	231	87	85	
October .....	558	291	74	196	-	120	1	
November .....	484	165	-	237	-	113	152	
December .....	372	355	68	244	-	23	105	
Totals	4,399	1,764	1,337	1,644	2,253	1,504	373	

<u>1919:</u>								
January .....	475	616	27	416	-	-	56	
February .....	439	1,054	17	461	-	27	94	
March .....	931	828	113	190	7	28	58	
April .....	895	607	173	206	-	44	-	
May .....	438	500	205	84	-	61	-	73
June .....	522	687	67	27	-	34	-	488
July .....	568	697	-	14	-	-	43	993
August .....	561	350	104	160	-	-	366	1,102
September .....	508	293	138	163	-	-	501	717
October .....	558	406	499	-	-	-	289	933
November .....	-	507	562	-	-	-	273	753
December .....	8	576	452	-	114	-	221	374
Totals	5,813	7,121	2,357	1,721	121	194	1,901	5,433



Canal Excavation Onlybetween Shovels and Disposition Points

E.S. #9	S.S. #10	S.S. #11	S.S. #12	S.S. #14	Misc. Equip.	Total Trains	Days per Month	Average Number of Trains per Day by Months
.....	.....	.....	.....	.....	.....	192	13	15
.....	.....	.....	.....	.....	.....	503	25	21
.....	.....	.....	.....	.....	.....	426	24	17
.....	.....	.....	.....	.....	.....	781	24	32
.....	.....	.....	.....	.....	.....	277	15	18
.....	.....	.....	.....	.....	.....	186	14	13
.....	.....	.....	.....	.....	.....	1,030	26	40
.....	.....	.....	.....	.....	.....	591	23	17

3,786

.....	.....	.....	.....	.....	.....	825	25	33
.....	.....	.....	.....	.....	.....	429	21	20
.....	.....	.....	.....	.....	.....	449	27	17
.....	.....	.....	.....	.....	.....	648	26	25
.....	.....	.....	.....	.....	.....	852	27	31
.....	.....	.....	.....	.....	.....	1,409	25	56
.....	.....	.....	.....	.....	.....	1,519	26	58
.....	.....	.....	.....	.....	.....	2,298	27	85
.....	.....	.....	.....	.....	.....	1,287	24	54
.....	.....	.....	.....	.....	.....	1,240	27	46
.....	.....	.....	.....	.....	.....	1,151	26	44
.....	.....	.....	.....	.....	.....	1,167	23	51

13,274

.....	.....	.....	.....	.....	.....	1,590	27	59
.....	.....	.....	.....	.....	.....	2,092	25	84
.....	.....	.....	.....	.....	.....	2,155	28	77
29	.....	.....	.....	.....	.....	1,864	29	64
69	.....	.....	.....	.....	9	1,439	26	55
816	44	.....	.....	.....	90	2,775	25	111
590	96	.....	.....	.....	100	3,101	25	124
580	57	.....	.....	.....	94	3,674	27	136
200	42	.....	.....	.....	139	2,701	25	108
590	16	.....	.....	.....	40	3,351	26	128
374	17	.....	.....	.....	54	2,540	25	102
1,160	14	.....	.....	.....	56	2,975	24	124

4,708      286      582      30,257



(10-10)

LET THE ENCLOSURE TO Mr. J. Allen Ross.

COPIES



Queenston-Chippawa Power DevelopmentTable showing Daily Train Movement, one way.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	S.S. #5	E.S. #6	S.S. #7	S.S. #8
<u>1920:</u>								
January ...	764	465	372	-	201		308	436
February ..	679	432	230	-	209		244	592
March .....	870	140	295	-	-		411	677
April .....	708	707	228	-	-		340	358
May .....	555	348	481	-	-		164	555
June .....	248	-	84	-	-		-	356
July .....	421	468	283	-	16		-	429
August .....	583	604	606	-	23		153	912
September .	610	346	691	-	10		510	1,111
October ...	683	339	323	59	3		439	879
November ..	589	475	373	550	-		404	587
December ..	498	591	344	448	-		332	747
Totals	7,208	4,913	4,304	1,057	462	-	3,305	7,639

<u>1921:</u>								
January ...	133	518	370	449	-		322	786
February ..	439	550	209	190	19		231	532
March .....	747	738	304	84	16		186	726
April .....	601	730	164	134	-		146	606
May .....	606	696	270	215	-		6	569
June .....	627	672	207	209	-		-	561
July .....	560	500	248	182	-		-	546
August .....	376	432	153	59	-		-	332
September .	394	478	148	45	4		-	310
October ...	502	340	61	66	22		-	675
November ..	68	366	-	-	-		-	-
Totals	5,053	6,020	2,134	1,633	61	-	891	5,645

Note: E.S.#1 denotes Shovel #1, Electric.  
S.S.#5 denotes Shovel #5, Steam.



Canal Excavation Onlybetween Shovels and Disposition Points (Continued)

S.S. #9	S.S. #10	S.S. #11	S.S. #12	S.S. #14	Misc. Equip.	Total Trains	Days per Month	Average Number of Trains per Day by Months
154 ...	83 .....				24 ...	2,805 ...	27 .....	104
159 ...	46 .....				90 ...	2,681 ...	23 .....	117
233 ...	- .....				94 ...	2,720 ...	27 .....	101
404 ...	- .....				48 ...	2,873 ...	25 .....	115
315 ...	- .....				46 ...	2,464 ...	25 .....	99
126 ...	- .....				5 ...	819 ...	13 .....	63
213 ...	- .....				14 ...	1,844 ...	20 .....	92
604 ...	109 .....				36 ...	3,632 ...	26 .....	140
315 ...	197 .....				- ...	3,780 ...	26 .....	145
254 ...	157 ...	411 .....			- ...	3,547 ...	25 .....	151
201 ...	71 ...	808 ...	75 ...	9 ...	- ...	4,224 ...	27 .....	156
243 ...	106 ...	672 ...	666 ...	- ...	29 ...	4,676 ...	26 .....	180
3,381	769	1,891	741	9	306	36,065		
259 ...	57 ...	801 ...	622 ...	157 ...	21 ...	4,495 ...	26 .....	173
360 ...	108 ...	1,080 ...	784 ...	325 ...	- ...	4,827 ...	26 .....	185
305 ...	140 ...	965 ...	903 ...	364 ...	1 ...	5,559 ...	29 .....	192
430 ...	226 ...	945 ...	897 ...	356 ...	29 ...	5,274 ...	29 .....	182
133 ...	42 ...	1,196 ...	482 ...	305 ...	57 ...	4,557 ...	30 .....	152
209 ...	- ...	1,069 ...	504 ...	351 ...	6 ...	4,495 ...	30 .....	146
394 ...	- ...	342 ...	417 ...	625 ...	- ...	3,814 ...	27 .....	141
355 ...	- ...	351 ...	183 ...	62 ...	13 ...	2,316 ...	27 .....	86
311 ...	- ...	408 ...	350 ...	- ...	15 ...	2,463 ...	26 .....	94
- ...	- ...	642 ...	466 ...	- ...	114 ...	2,894 ...	27 .....	107
- ...	- ...	445 ...	376 ...	- ...	31 ...	1,286 ...	26 .....	49
2,924	573	8,250	5,984	2,545	267	41,980		

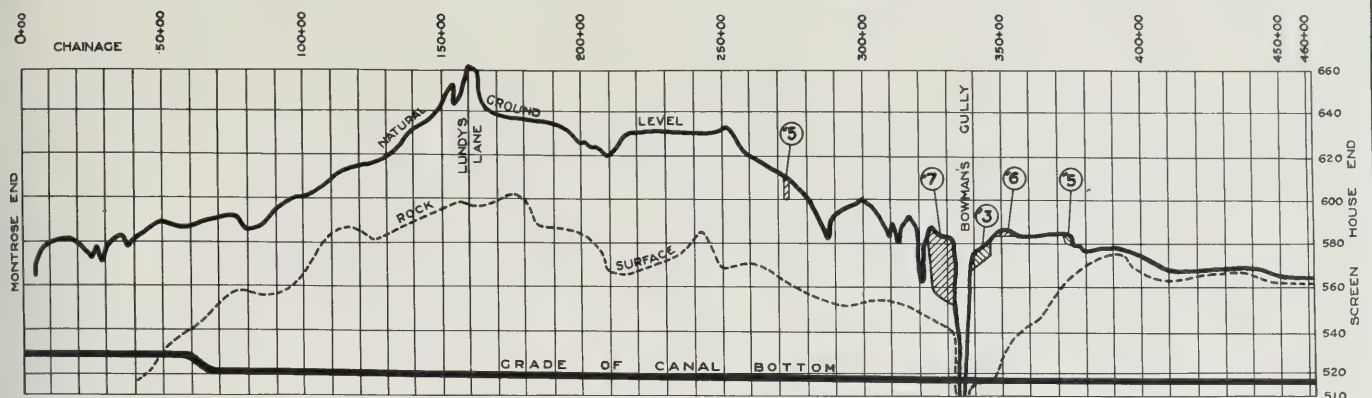
MAY 1917 TO JANUARY 1918

Table 1: Summary of Data

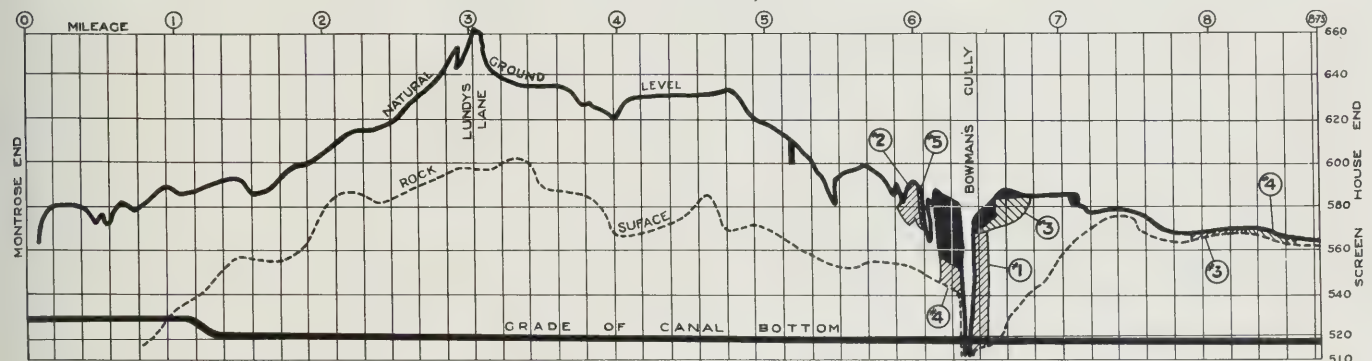
Year	Q1	Q2	Q3	Q4	Total
2011	100	120	110	130	460
2012	110	130	120	140	500
2013	120	140	130	150	540
2014	130	150	140	160	580
2015	140	160	150	170	620
2016	150	170	160	180	660
2017	160	180	170	190	700
2018	170	190	180	200	740
2019	180	200	190	210	780
2020	190	210	200	220	820
2021	200	220	210	230	860
2022	210	230	220	240	900
2023	220	240	230	250	940
2024	230	250	240	260	980
2025	240	260	250	270	1020
2026	250	270	260	280	1060
2027	260	280	270	290	1100
2028	270	290	280	300	1140
2029	280	300	290	310	1180
2030	290	310	300	320	1220
2031	300	320	310	330	1260
2032	310	330	320	340	1300
2033	320	340	330	350	1340
2034	330	350	340	360	1380
2035	340	360	350	370	1420
2036	350	370	360	380	1460
2037	360	380	370	390	1500
2038	370	390	380	400	1540
2039	380	400	390	410	1580
2040	390	410	400	420	1620
2041	400	420	410	430	1660
2042	410	430	420	440	1700
2043	420	440	430	450	1740
2044	430	450	440	460	1780
2045	440	460	450	470	1820
2046	450	470	460	480	1860
2047	460	480	470	490	1900
2048	470	490	480	500	1940
2049	480	500	490	510	1980
2050	490	510	500	520	2020
2051	500	520	510	530	2060
2052	510	530	520	540	2100
2053	520	540	530	550	2140
2054	530	550	540	560	2180
2055	540	560	550	570	2220
2056	550	570	560	580	2260
2057	560	580	570	590	2300
2058	570	590	580	600	2340
2059	580	600	590	610	2380
2060	590	610	600	620	2420
2061	600	620	610	630	2460
2062	610	630	620	640	2500
2063	620	640	630	650	2540
2064	630	650	640	660	2580
2065	640	660	650	670	2620
2066	650	670	660	680	2660
2067	660	680	670	690	2700
2068	670	690	680	700	2740
2069	680	700	690	710	2780
2070	690	710	700	720	2820
2071	700	720	710	730	2860
2072	710	730	720	740	2900
2073	720	740	730	750	2940
2074	730	750	740	760	2980
2075	740	760	750	770	3020
2076	750	770	760	780	3060
2077	760	780	770	790	3100
2078	770	790	780	800	3140
2079	780	800	790	810	3180
2080	790	810	800	820	3220
2081	800	820	810	830	3260
2082	810	830	820	840	3300
2083	820	840	830	850	3340
2084	830	850	840	860	3380
2085	840	860	850	870	3420
2086	850	870	860	880	3460
2087	860	880	870	890	3500
2088	870	890	880	900	3540
2089	880	900	890	910	3580
2090	890	910	900	920	3620
2091	900	920	910	930	3660
2092	910	930	920	940	3700
2093	920	940	930	950	3740
2094	930	950	940	960	3780
2095	940	960	950	970	3820
2096	950	970	960	980	3860
2097	960	980	970	990	3900
2098	970	990	980	1000	3940
2099	980	1000	990	1010	3980
2100	990	1010	1000	1020	4020

COPY

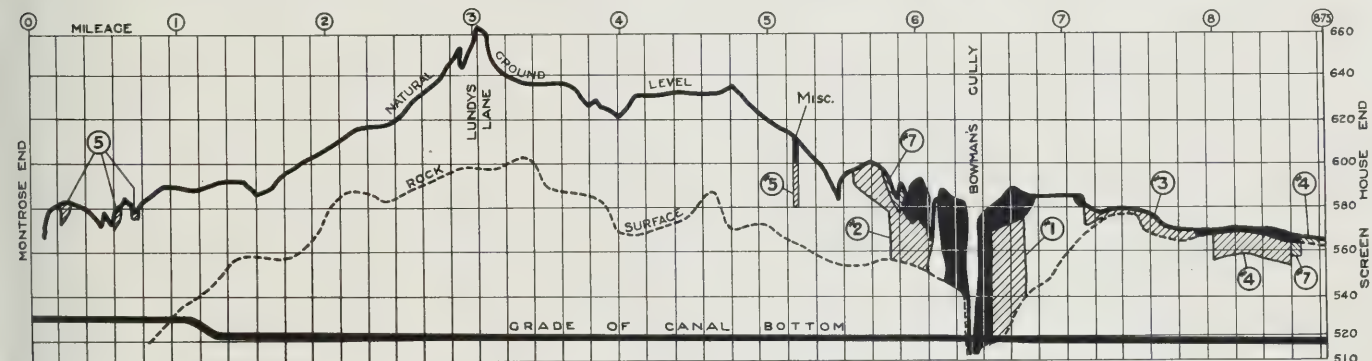




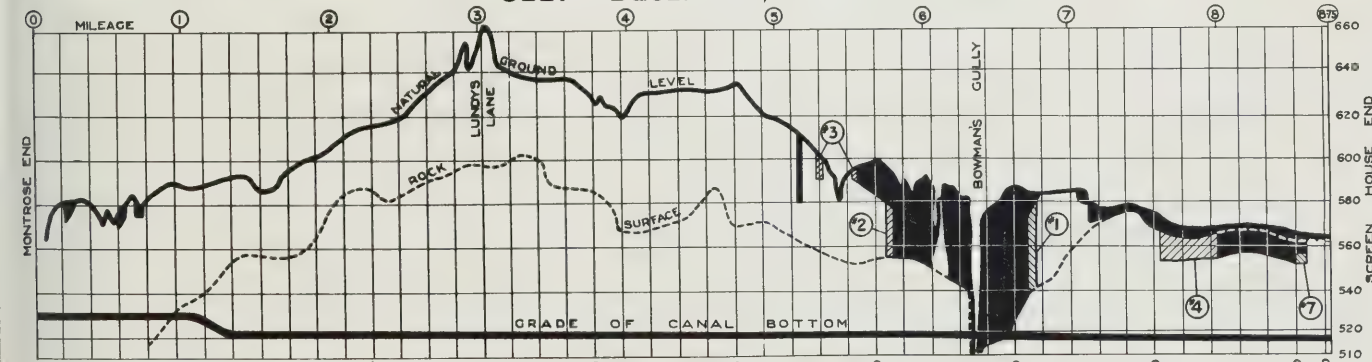
MAY - DECEMBER, 1917



JANUARY - JUNE, 1918

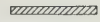


JULY - DECEMBER, 1918







MONTH OF JANUARY, 1919

MAY, 1917 TO JANUARY, 1919

EXCAVATION DURING MONTH INDICATED, SHOWN THUS: 

COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK

EXCAVATING UNITS SHOWN THUS:  

MILEAGE SHOWN THUS:  

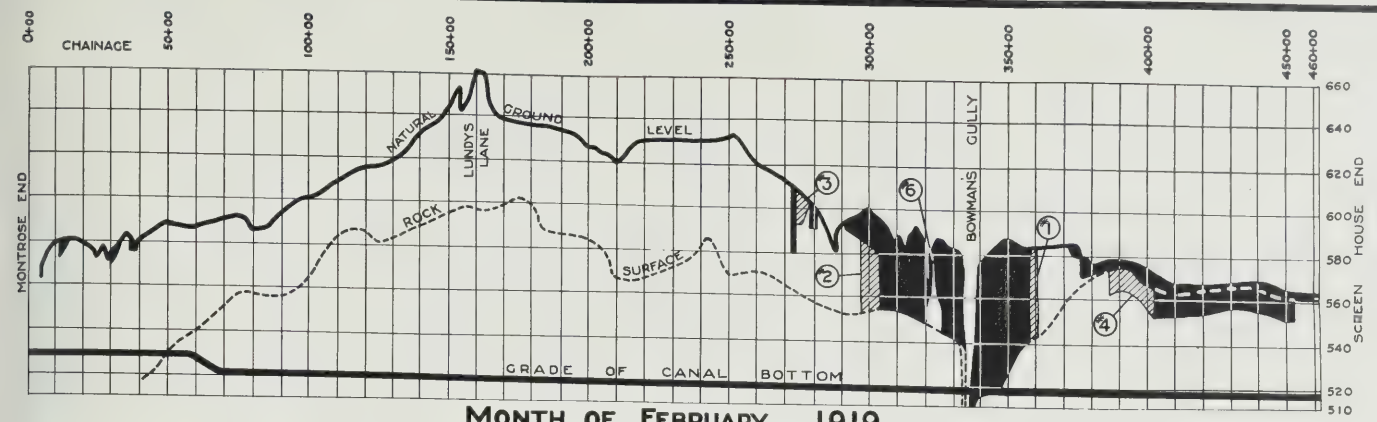
ELEVATIONS ARE REFERRED TO H.E.P.C. DATUM



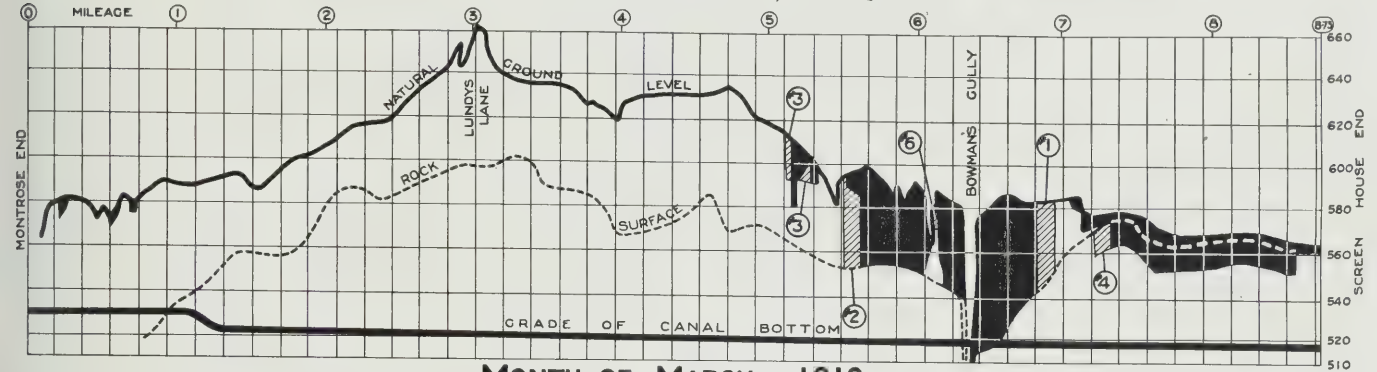
HYDRO-ELECTRIC INQUIRY COMMISSION  
W. D. GREGORY - CHAIRMAN  
QUEENSTON-CHIPPAWA POWER DEVELOPMENT  
**CANAL EARTH AND ROCK EXCAVATION  
PROGRESS CHARTS**  
SHEET 1 OF A SERIES OF 10 SHEETS  
Toronto, Mar. 10th, 1923. Made by *W.J.F.* Checked by *W.J.F.*  
WALTER J. FRANCIS, C.E.,  
CONSULTING ENGINEER



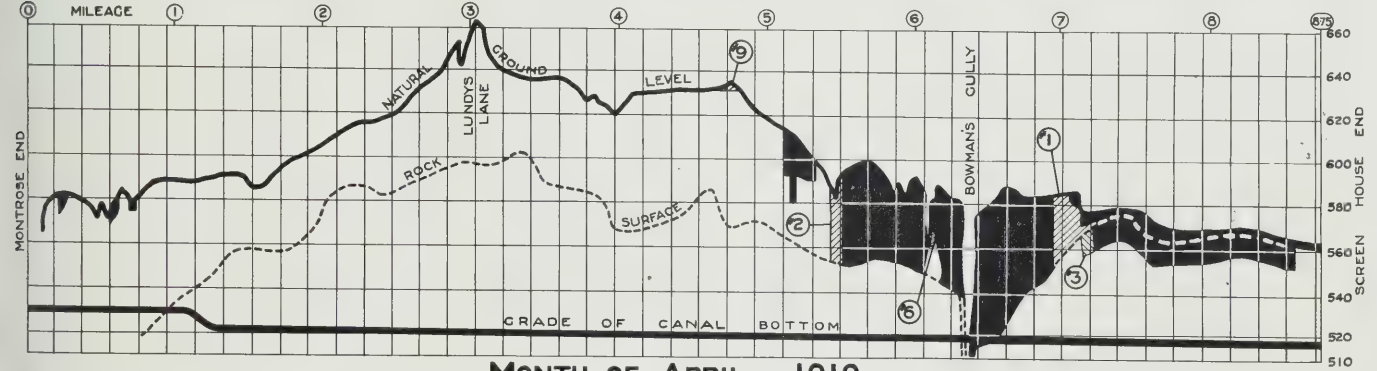




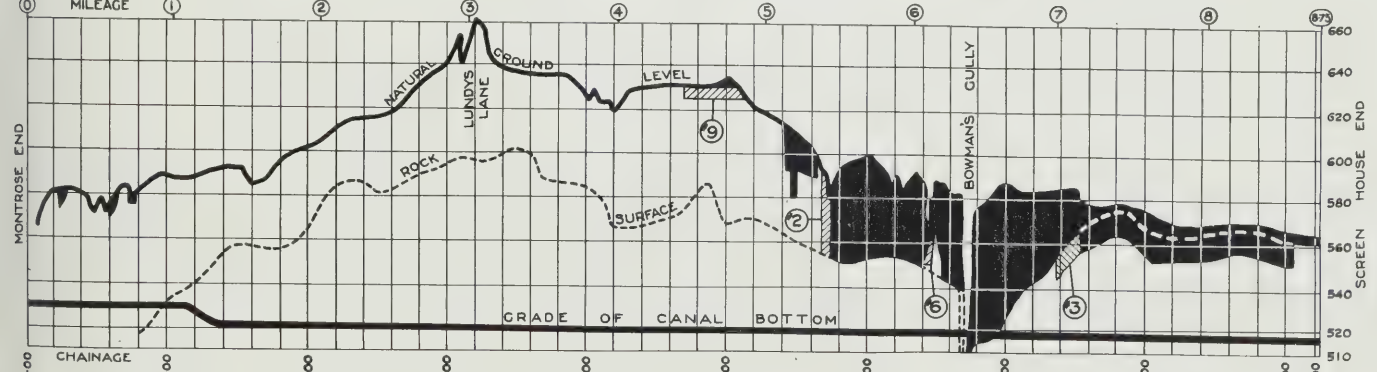
MONTH OF FEBRUARY, 1919



MONTH OF MARCH, 1919






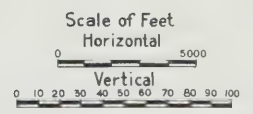
MONTH OF APRIL, 1919



MONTH OF MAY, 1919

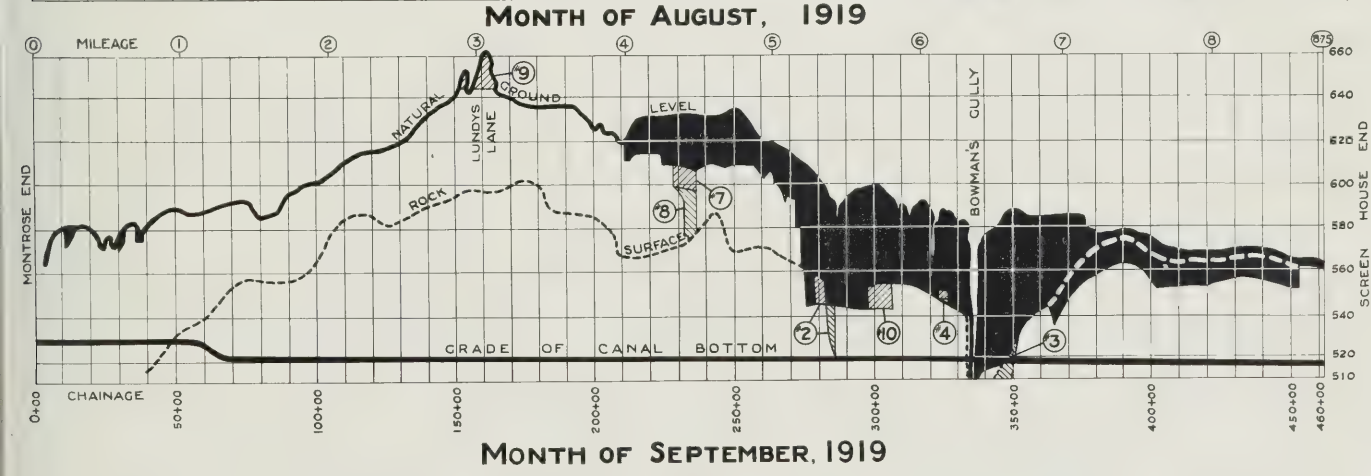
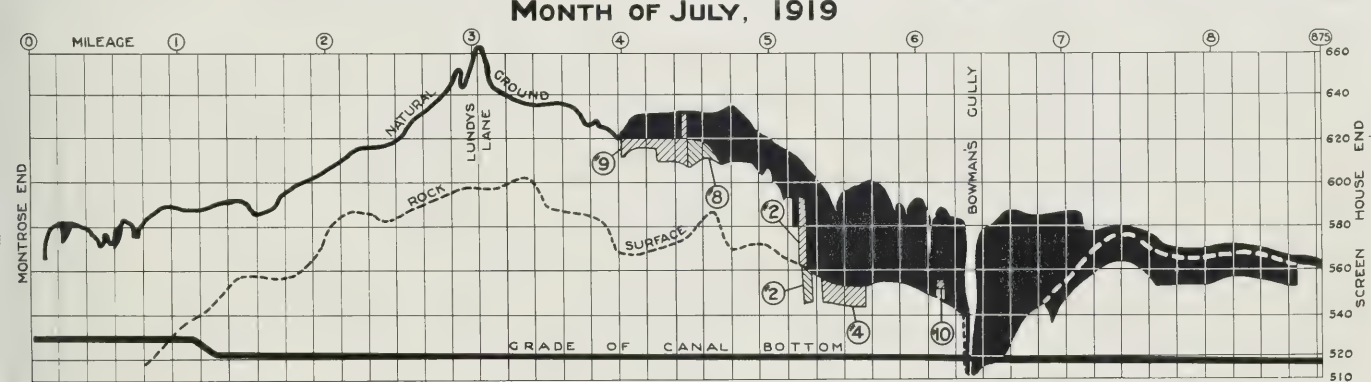
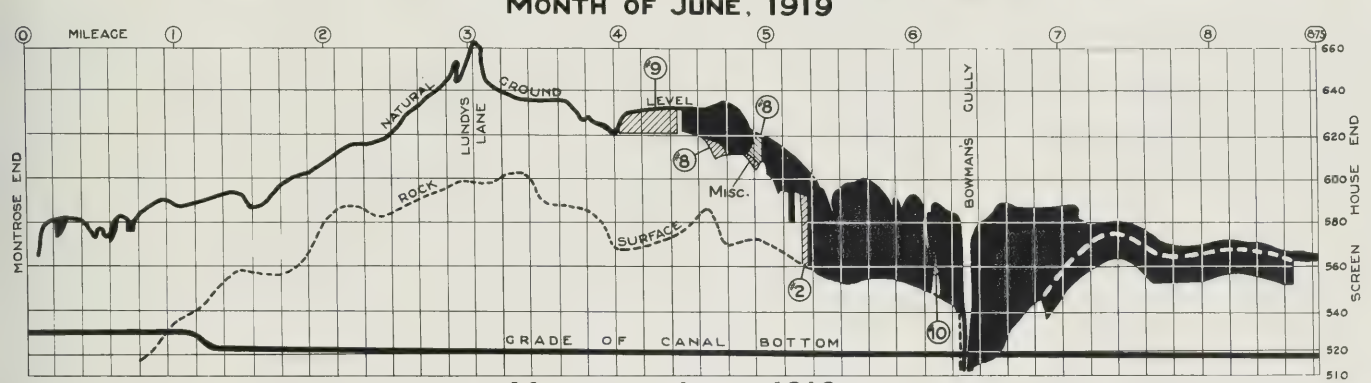
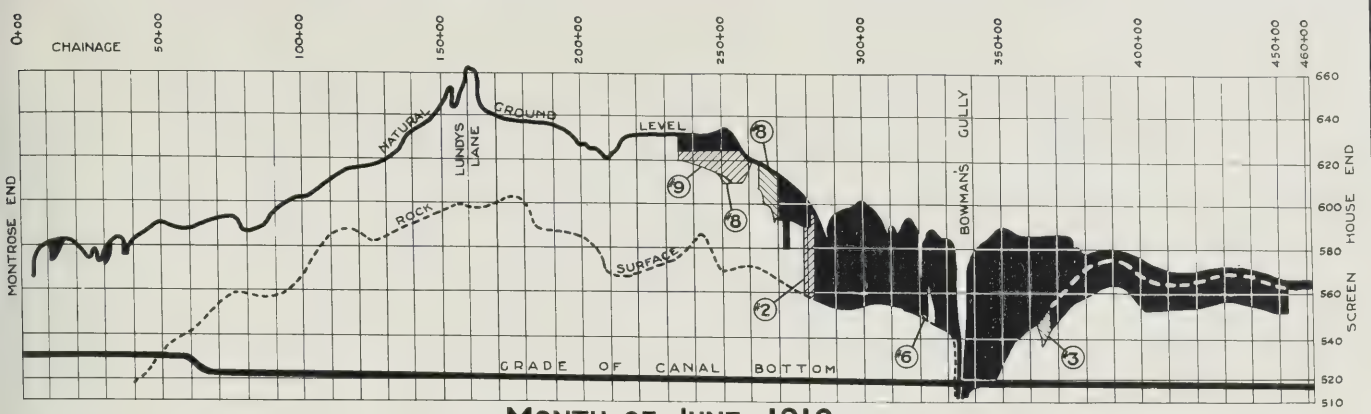
FEBRUARY, 1919 TO MAY, 1919

EXCAVATION DURING MONTH INDICATED, SHOWN THUS:-   
" COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
EXCAVATING UNITS SHOWN THUS:-   
MILEAGE SHOWN THUS:-   
ELEVATIONS ARE REFERRED TO M.E.P.C. DATUM






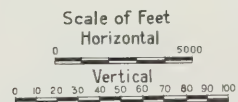




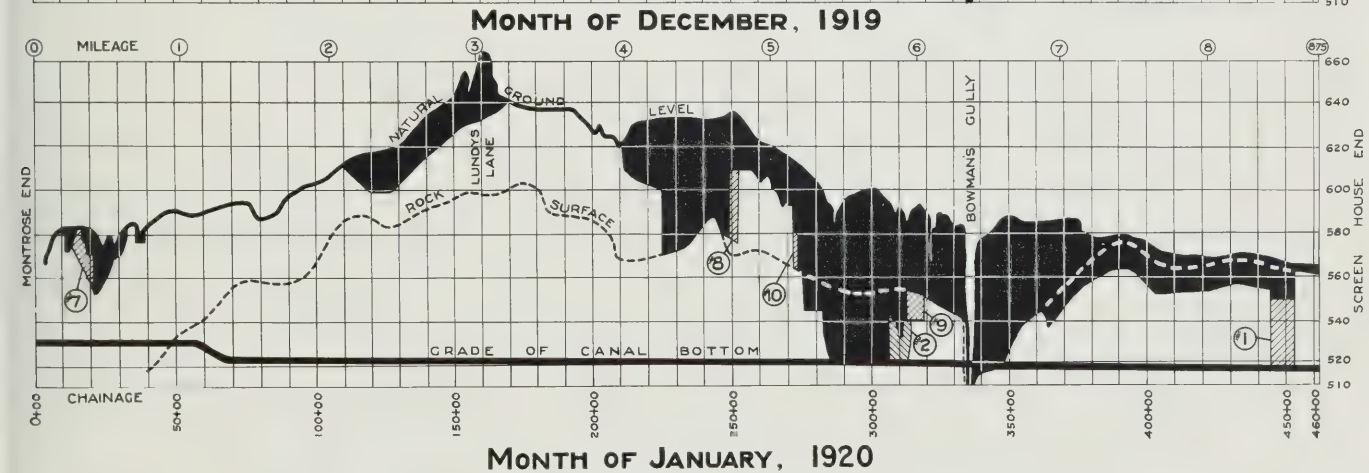
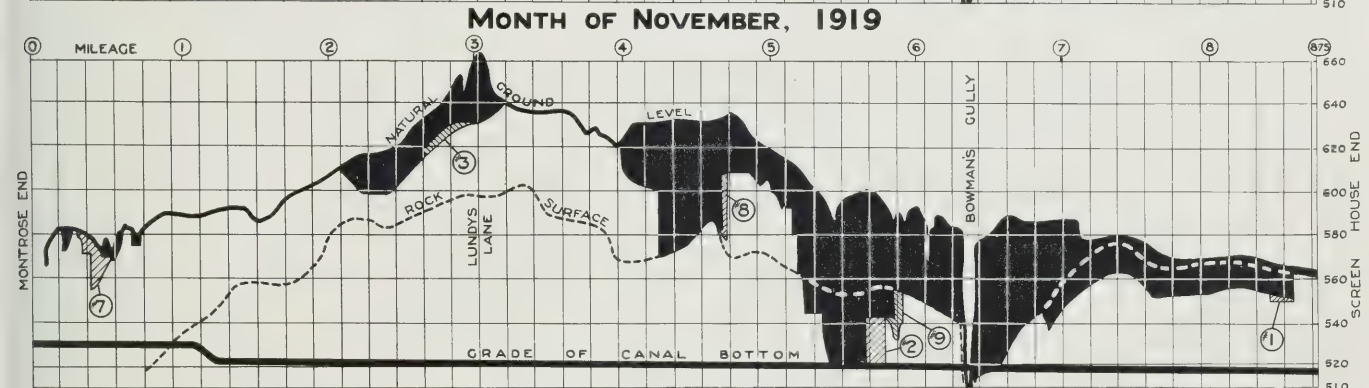
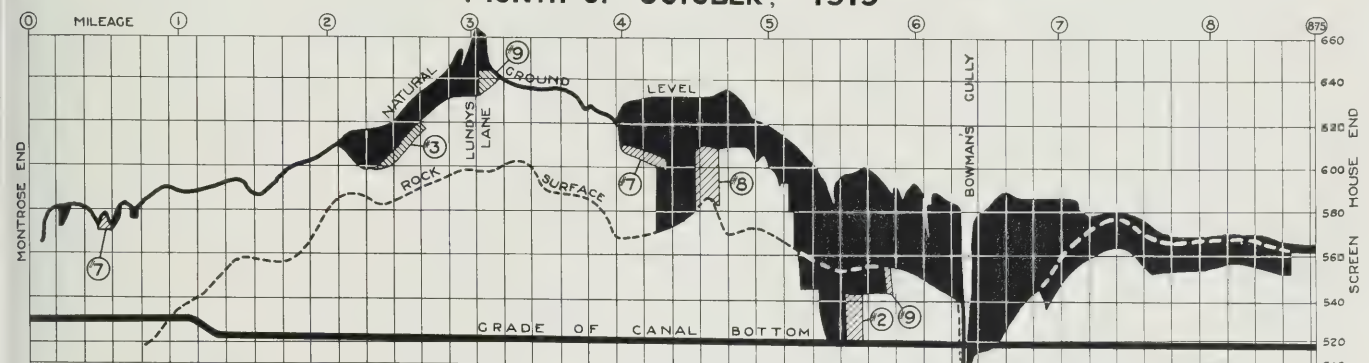
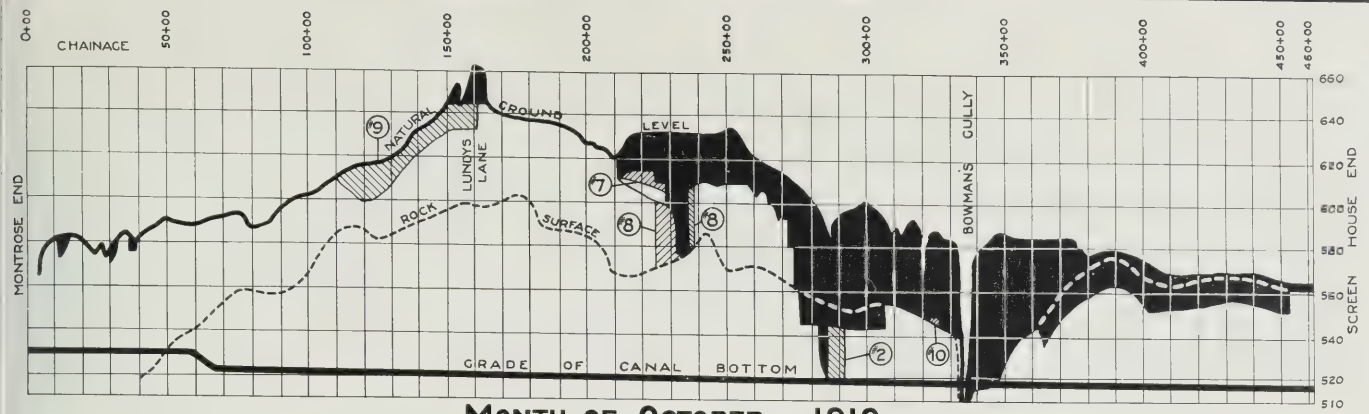


## JUNE, 1919 TO SEPTEMBER, 1919

EXCAVATION DURING MONTH INDICATED, SHOWN THUS: -   
\* COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
EXCAVATING UNITS SHOWN THUS: -   
MILEAGE SHOWN THUS: -   
ELEVATIONS ARE REFERRED TO H.E.P.C. DATUM







## OCTOBER, 1919 TO JANUARY, 1920

EXCAVATION DURING MONTH INDICATED, SHOWN THUS:

\* COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK

EXCAVATING UNITS SHOWN THUS:

MILEAGE SHOWN THUS:

ELEVATIONS ARE REFERRED TO H.E.P.C. DATUM

Scale of Feet

Horizontal

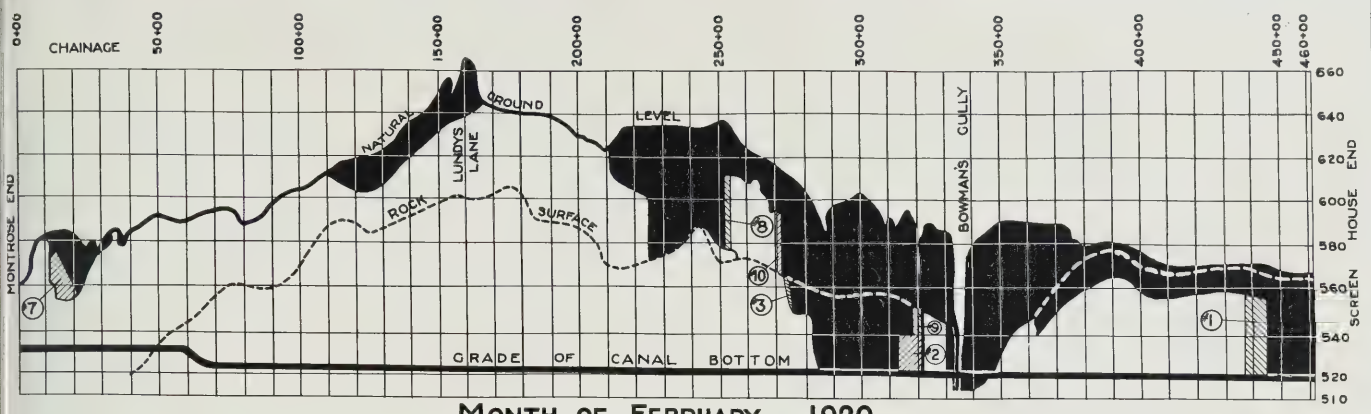
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Vertical

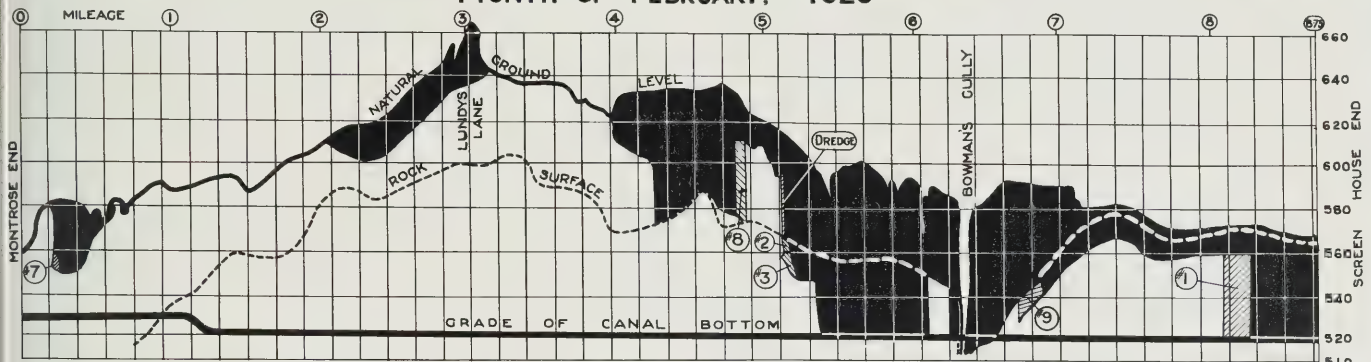
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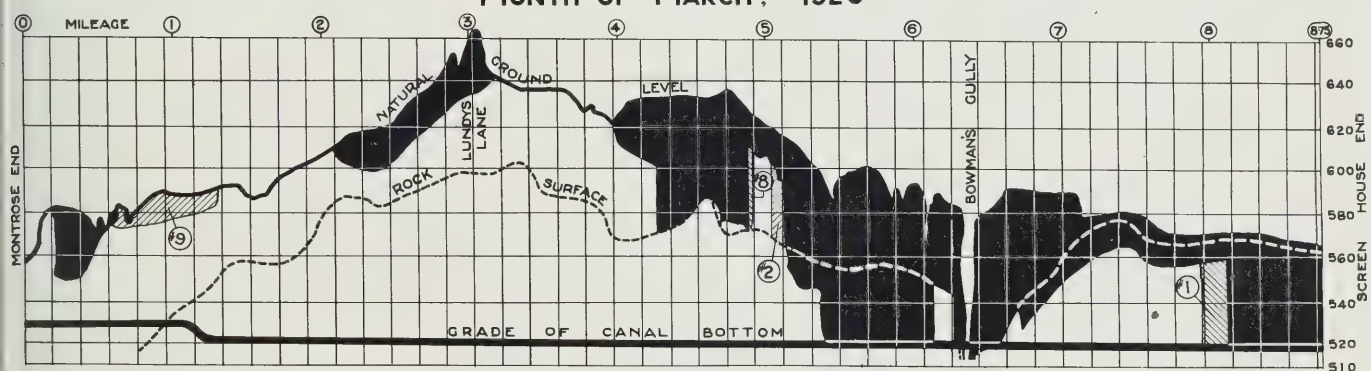




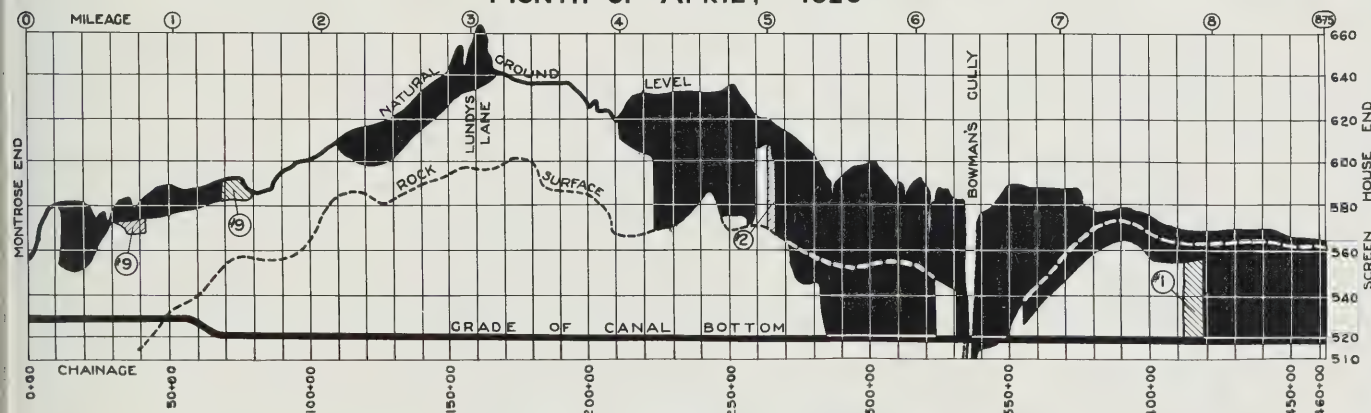
MONTH OF FEBRUARY, 1920



MONTH OF MARCH, 1920






MONTH OF APRIL, 1920



MONTH OF MAY, 1920

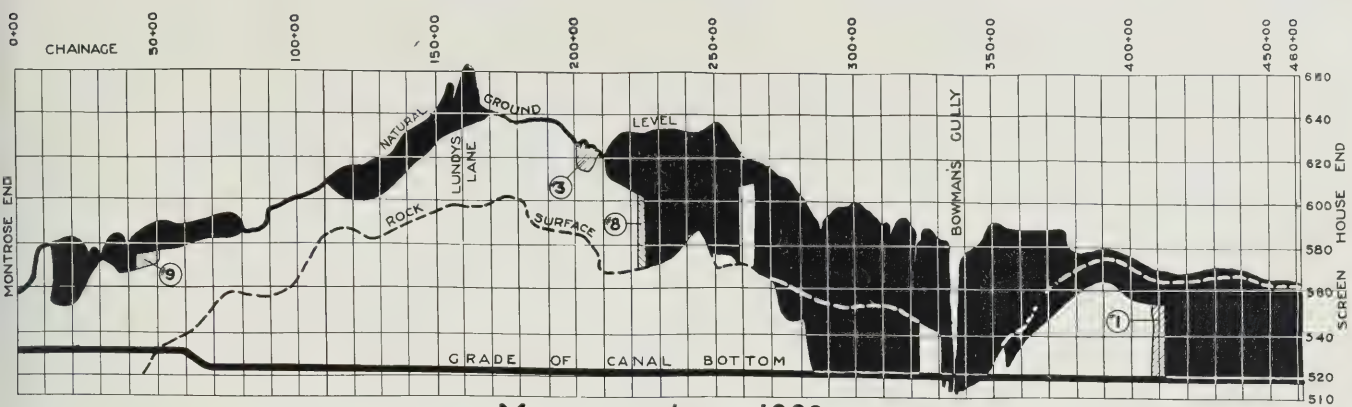
## FEBRUARY, 1920 TO MAY, 1920

CAVATION DURING MONTH INDICATED, SHOWN THUS:   
" COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
CAVATING UNITS SHOWN THUS:   
LEAGE SHOWN THUS:   
ELEVATIONS ARE REFERRED TO M.E.P.C. DATUM

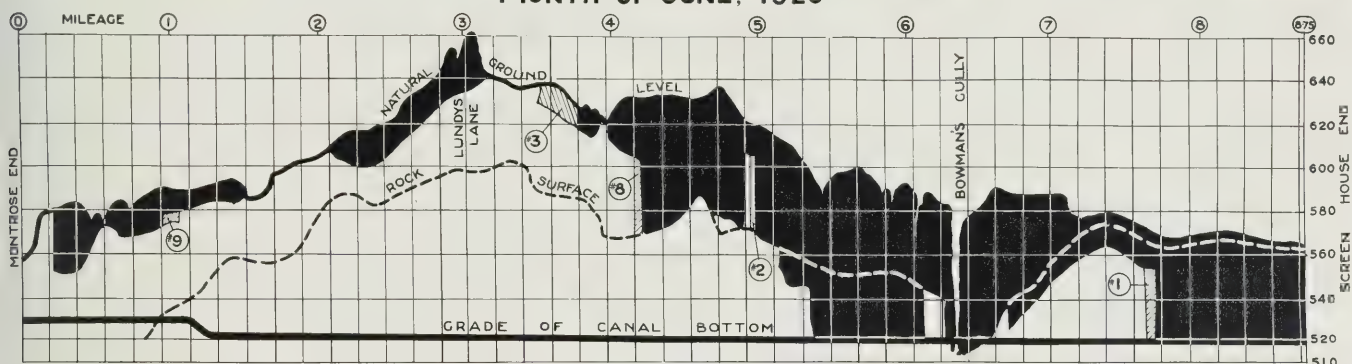




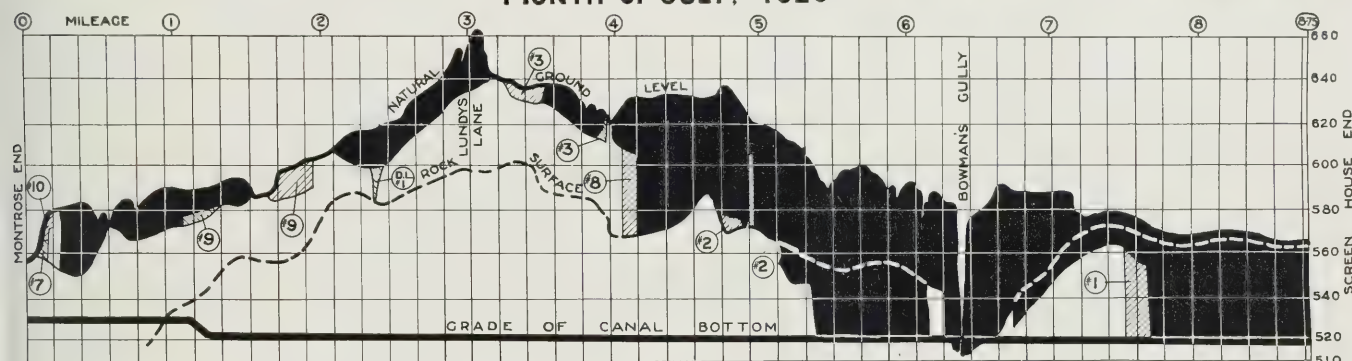




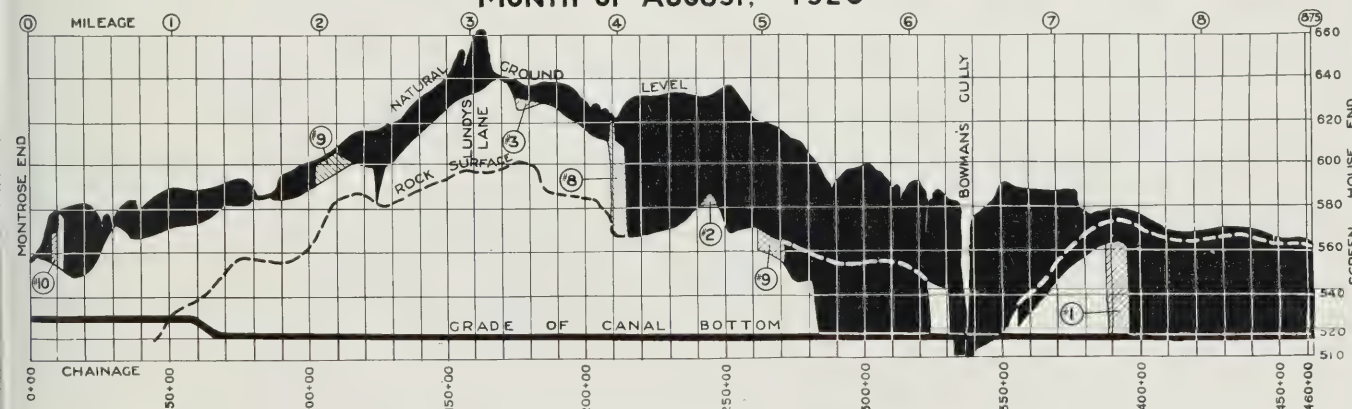
MONTH OF JUNE, 1920



MONTH OF JULY, 1920




MONTH OF AUGUST, 1920





MONTH OF SEPTEMBER, 1920

JUNE, 1920 TO SEPTEMBER, 1920

EXCAVATION DURING MONTH INDICATED, SHOWN THUS: 

COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK

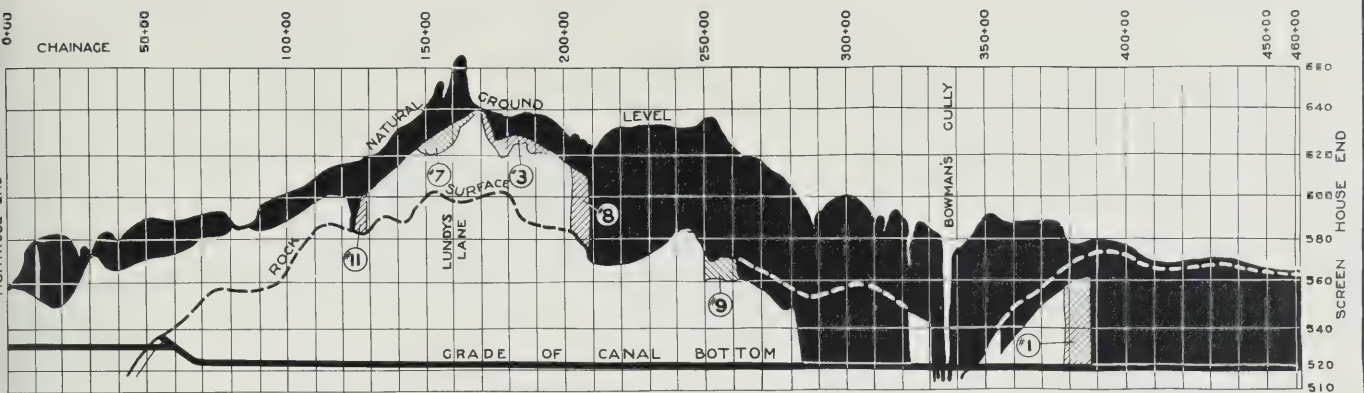
EXCAVATING UNITS SHOWN THUS: 

MILEAGE SHOWN THUS: 

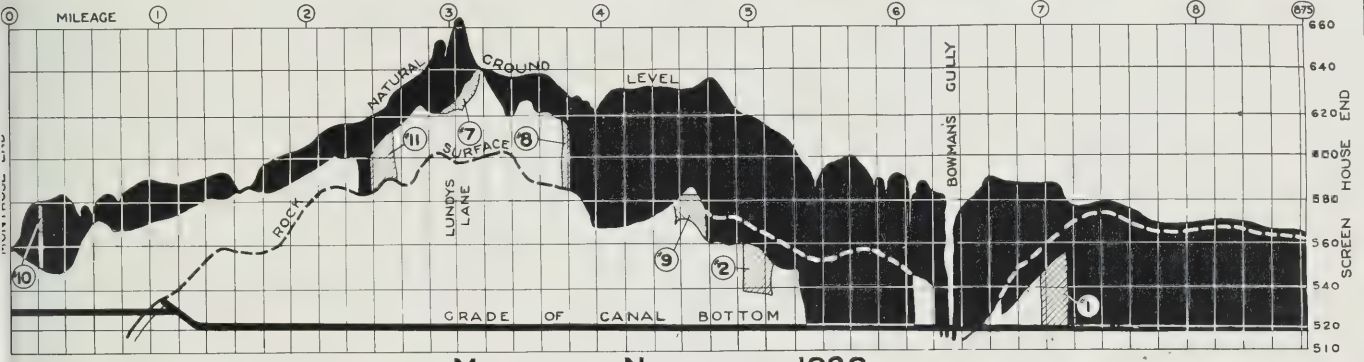
ELEVATIONS ARE REFERRED TO M.E.P.C. DATUM



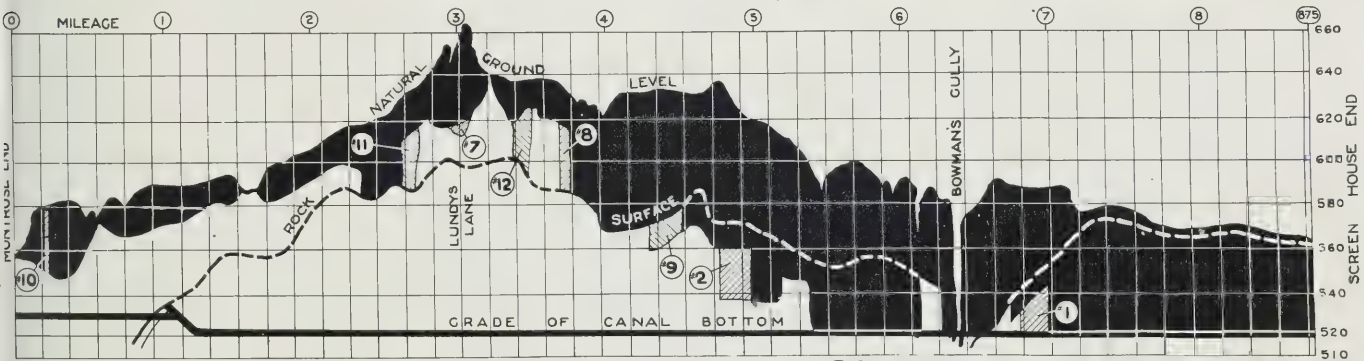




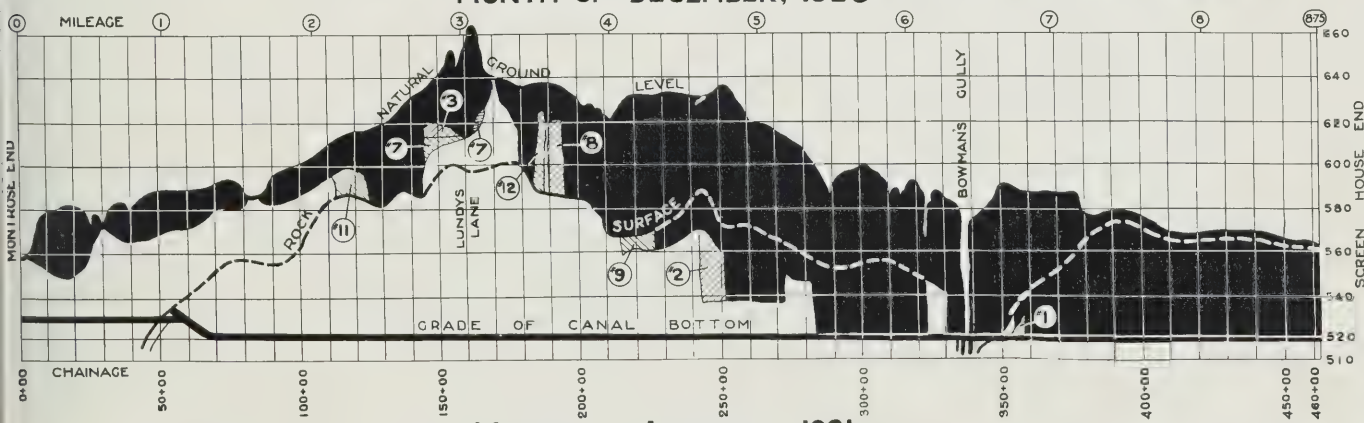
MONTH OF OCTOBER, 1920



MONTH OF NOVEMBER, 1920






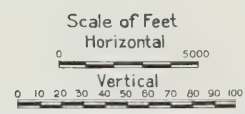
MONTH OF DECEMBER, 1920



MONTH OF JANUARY, 1921

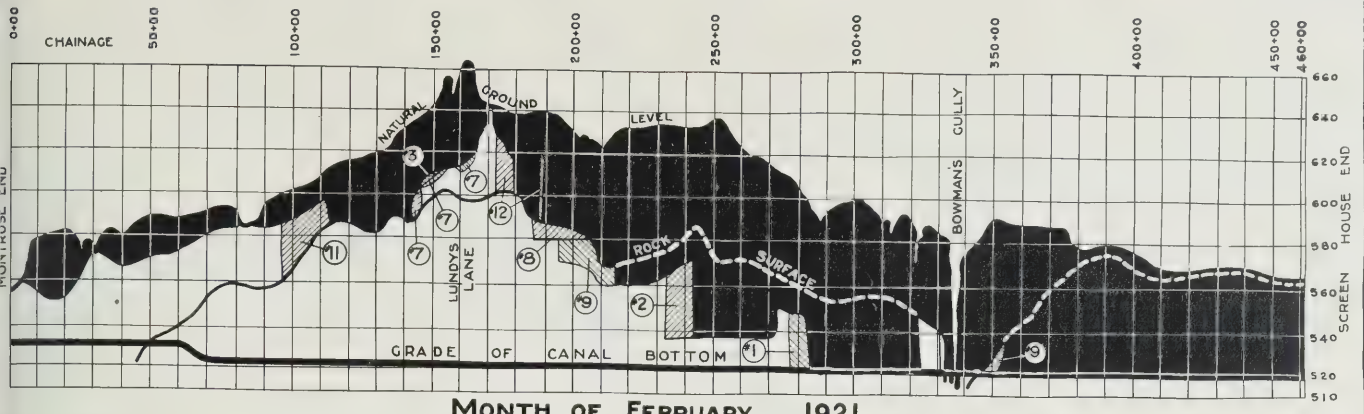
# OCTOBER, 1920 TO JANUARY, 1921

CAVATION DURING MONTH INDICATED, SHOWN THUS:-   
COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
CAVATING UNITS SHOWN THUS:-   
MILEAGE SHOWN THUS:-   
ELEVATIONS ARE REFERRED TO M.E.P.C. DATUM

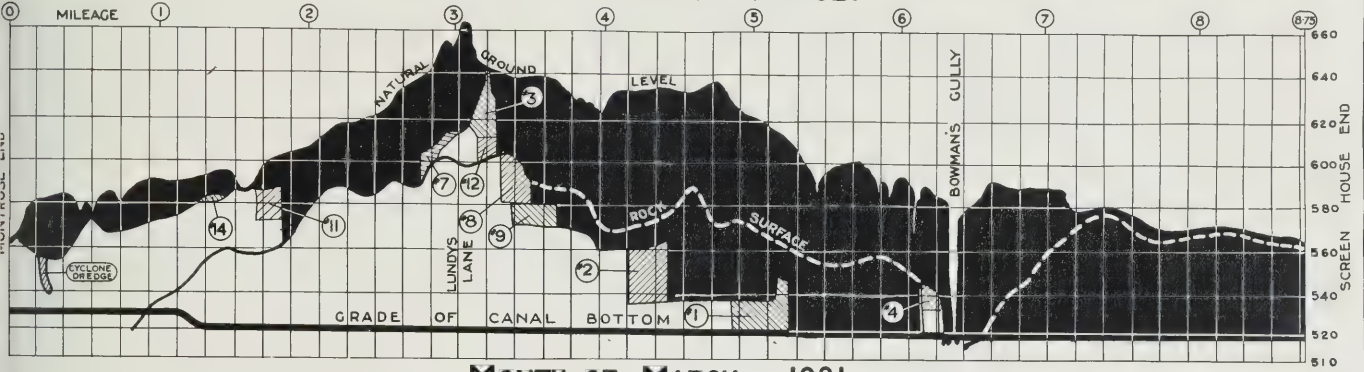




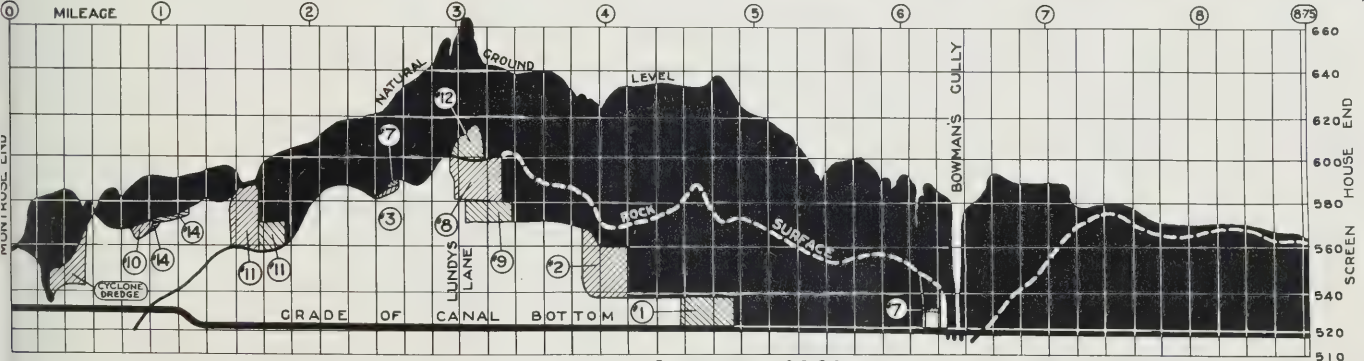




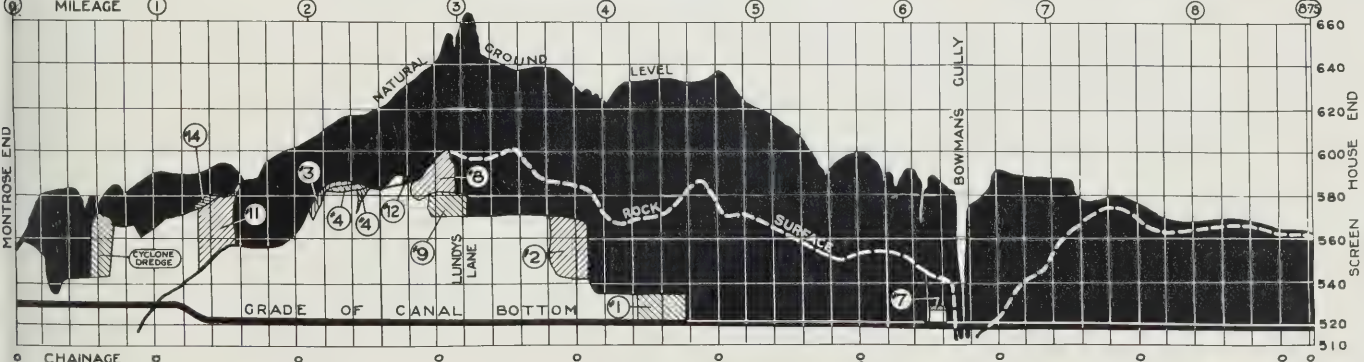
MONTH OF FEBRUARY, 1921



MONTH OF MARCH, 1921






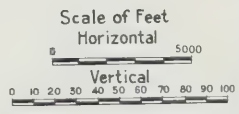
MONTH OF APRIL, 1921



MONTH OF MAY, 1921

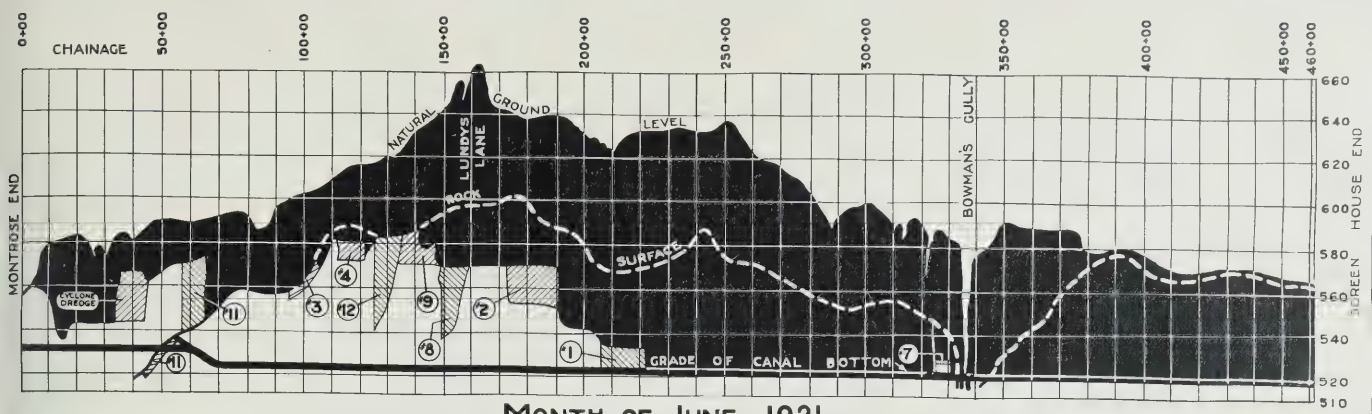
# FEBRUARY, 1921 TO MAY, 1921

CAVATION DURING MONTH INDICATED, SHOWN THUS:-   
" COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
CAVATING UNITS SHOWN THUS:-   
LEAGE SHOWN THUS:-   
ELEVATIONS ARE REFERRED TO M.E.P.C. DATUM

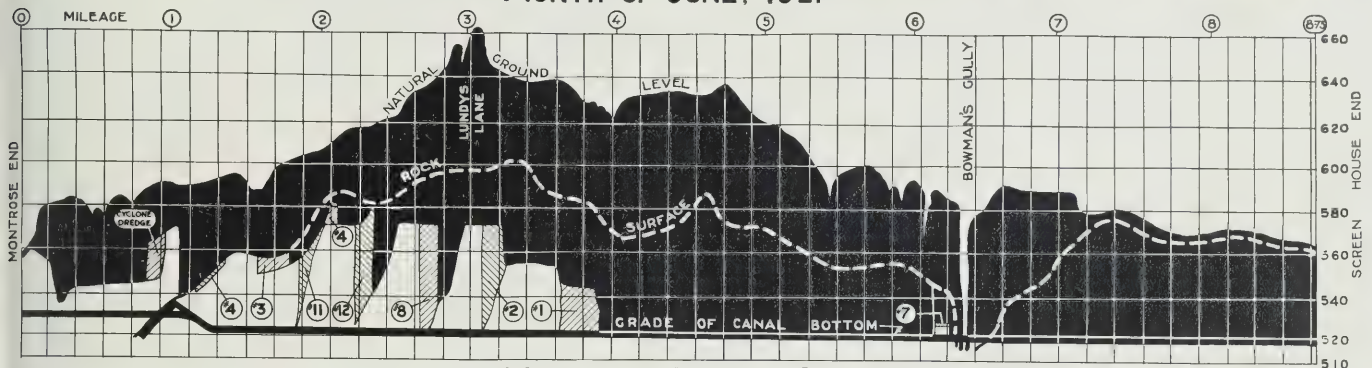




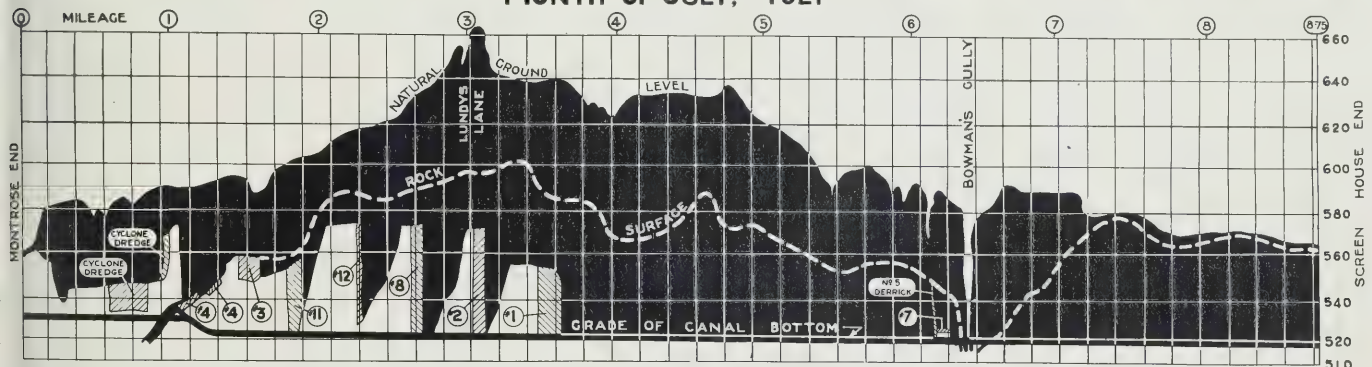




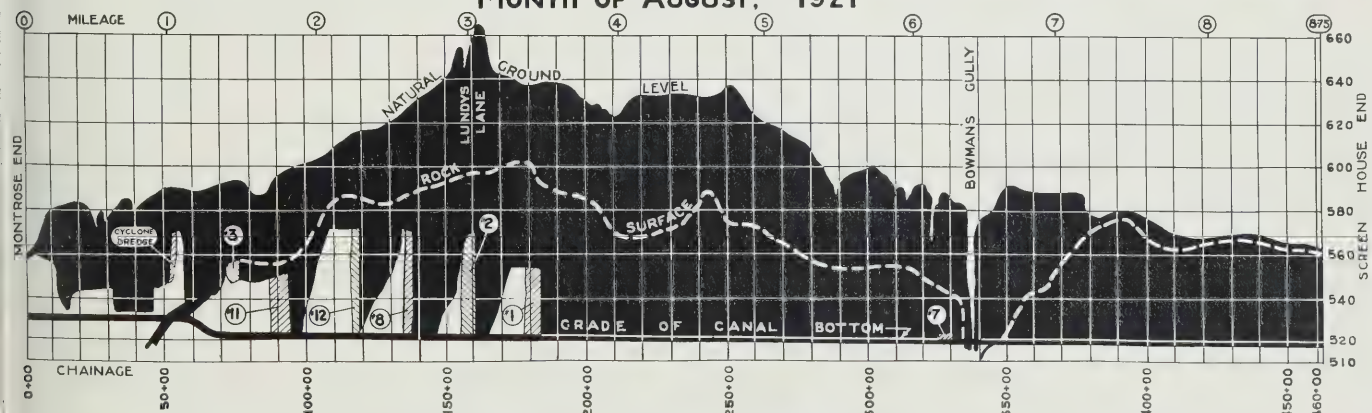
MONTH OF JUNE, 1921



MONTH OF JULY, 1921



MONTH OF AUGUST, 1921



MONTH OF SEPTEMBER, 1921

JUNE 1921 TO SEPTEMBER, 1921

CAVATION DURING MONTH INDICATED, SHOWN THUS:-

" COMPLETED PRIOR TO MONTH INDICATED. SHOWN IN BLACK

CAVATING UNITS SHOWN THUS:-

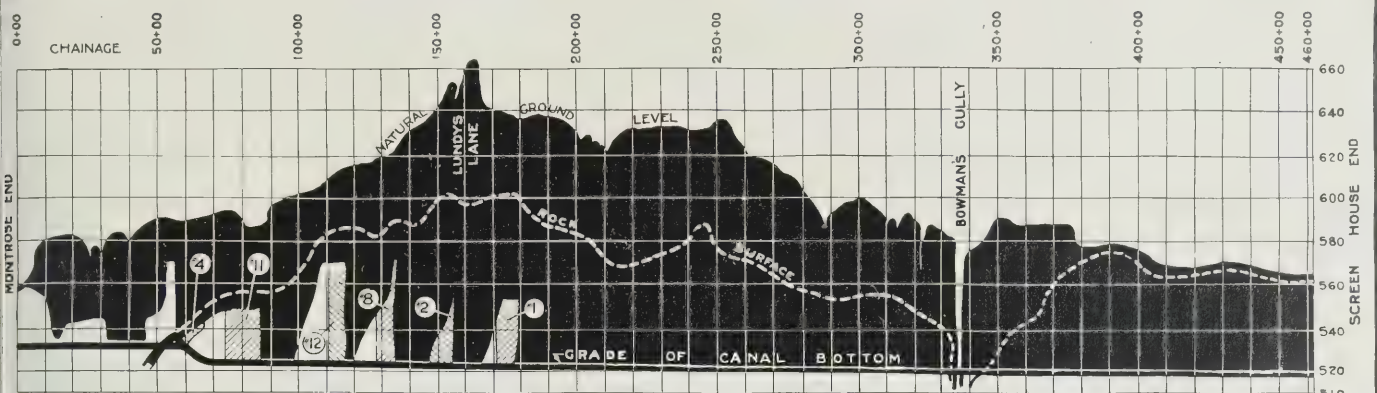
LEAGE SHOWN THUS:-

ELEVATIONS ARE REFERRED TO H.E.P.C. DATUM

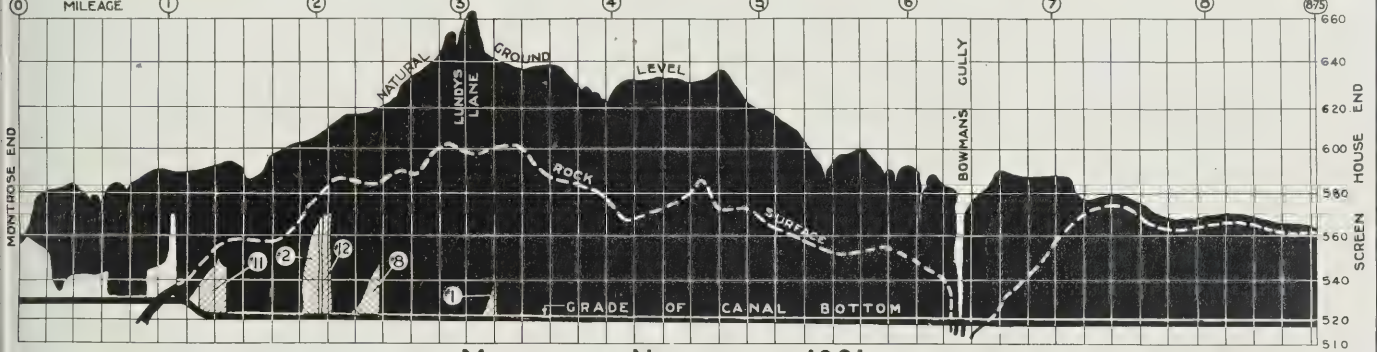




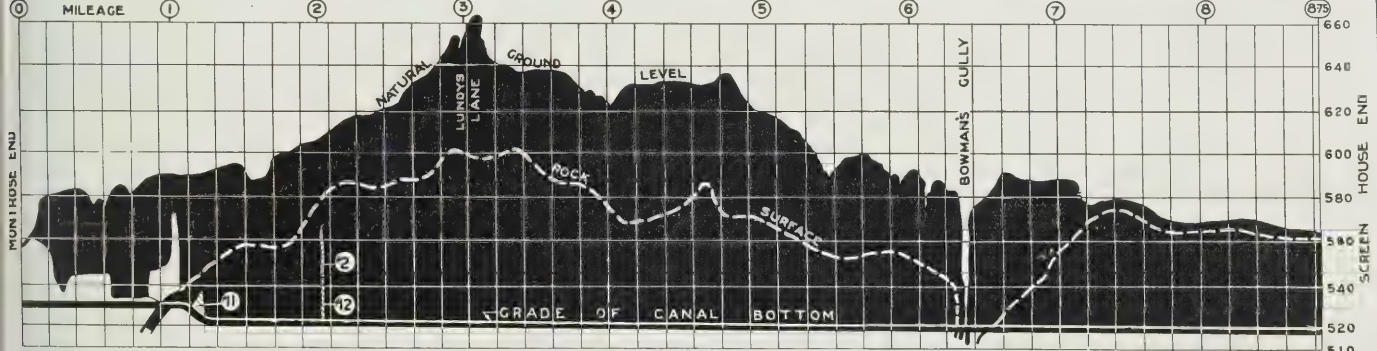




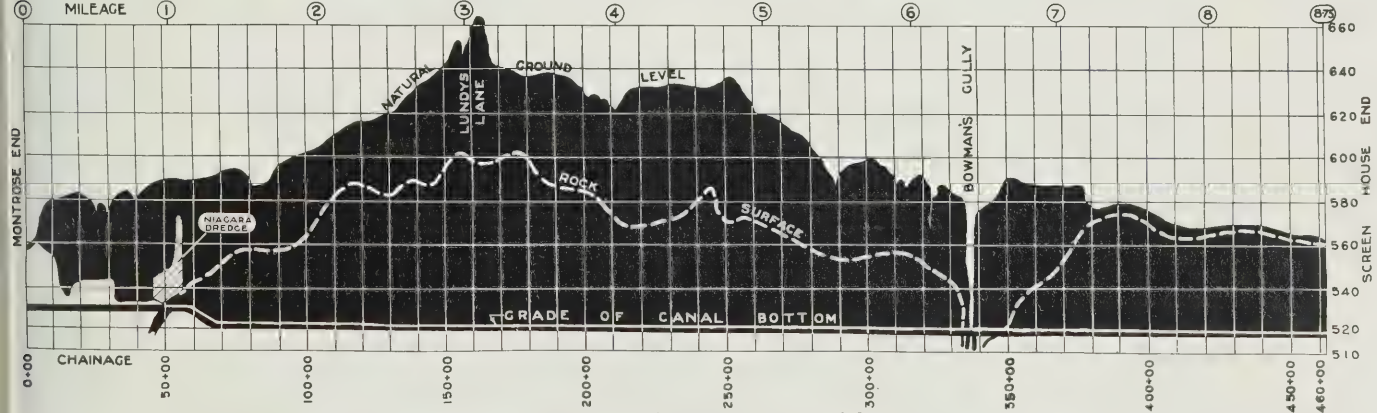
MONTH OF OCTOBER, 1921



MONTH OF NOVEMBER, 1921






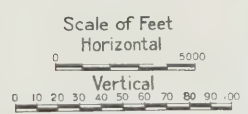
MONTH OF DECEMBER, 1921



MONTH OF JANUARY, 1922

# OCTOBER, 1921 TO JANUARY, 1922

CAVATION DURING MONTH INDICATED, SHOWN THUS:-   
COMPLETED PRIOR TO MONTH INDICATED, SHOWN IN BLACK  
CAVATING UNITS SHOWN THUS:-   
LEAGE SHOWN THUS:-   
ELEVATIONS ARE REFERRED TO H.E.P.C. DATUM









Queenston-Chippawa Power DevelopmentTable showing Total Quantities of Earth and Rock Excavated.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	S.S. #5	E.S. #6
<u>1917:</u>						
May .....					5,599	
June .....					240	
July .....					810	
August .....					4,208	1,220
September .....						
October .....						
November .....						
December .....		9,236			-	2,173
<u>1918:</u>						
January .....		26,256	7,396	2,339	1,580	
February .....		24,065	14,715	-	2,806	
March .... 8,300		32,912	11,749	-	-	
April .... 42,840		15,402	21,068	-	472	
May .... 44,378	15,666	2,245	4,463	-	2,579	
June .... 51,589	19,930	5,715	1,391	3,975	6,927	
July .... 80,449	-	28,042	-	3,229	7,548	
August .. 107,350	43,938	13,660	579	5,750	2,595	
September 4,600	53,005	17,297	-	1,008	4,447	
October .. 57,116	46,629	11,519	2,527	-	9,750	
November . 66,085	25,258	949	22,631	-	3,000	
December . 45,888	43,239	21,429	24,445	-	723	
<u>1919:</u>						
January .. 62,127	61,856	3,466	31,376	510	-	
February . 61,929	155,468	4,607	34,527	-	5,668	
March ... 124,230	122,916	3,414	7,123	1,755	3,707	
April ... 100,441	97,166	5,106	-	-	7,159	
May .....	66,818	19,737	-	-	7,888	
June ....	100,719	6,529	2,229	-	1,507	
July ....	91,558	352	9,154	890		
August ..	57,367	15,021	12,799	1,076		
September -	22,779	12,951	13,690	-		
October ..	31,985	51,669	-	-		
November .	35,352	88,173	-	243		
December . 4,960	40,378	51,179	-	3,977		



Canal Excavation Onlymonth by month, by the several Excavating Units

S.S. #7	S.S. #8	S.S. #9	S.S. #10	S.S. #11	S.S. #12	S.S. #14	Misc. Equip.
7,100							
20,100							
17,324							
14,982							2,025
11,885							1,827
7,592							25
17,329							125
13,207							-
3,136							-
1,211							-
-							8
-							510
-							48
-							-
-							1,500
5,534							-
13,711							-
914							-
-							-
3,270							-
1,380							-
-							700
-							1,813
-		335					1,917
-	5,600	47,092					2,089
-	56,279	75,591	1,477				11,398
2,690	130,469	89,646	10,663				7,306
87,220	175,803	128,059	4,321				6,648
56,847	97,448	27,443	6,091				15,229
46,457	102,665	71,885	700				4,237
42,072	130,363	64,749	1,732				5,370
22,031	45,298	9,279	1,449				6,596

Queenston-Chippawa Power DevelopmentTable showing Total Quantities of Earth and Rock Excavated.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	S.S. #5	E.S. #6
<u>1920:</u>						
January ..	65,445	34,308	44,242	-	4,088	
February .	50,236	37,478	39,500	-	2,323	
March ....	68,152	2,498	18,348	-	-	
April ....	62,406	100,625	44,309	-	-	
May .....	47,761	63,146	81,015	-	-	
June .....	31,894	-	11,804	-	-	
July .....	24,938	38,904	27,958	-	1,250	
August ...	65,258	102,893	86,625	-	1,830	
September	69,978	53,340	93,518	-	1,521	
October ..	77,410	60,800	59,425	-	1,135	
November .	69,017	41,512	55,358	62,768	3,099	
December .	41,132	51,059	36,120	48,071	2,097	
<u>1921:</u>						
January ..	18,488	49,248	41,345	62,998	1,142	
February .	34,796	53,313	28,490	28,482	5,421	
March ....	71,020	60,347	39,092	11,677	1,017	
April ....	60,567	78,839	10,835	8,291	-	
May .....	53,159	67,418	18,862	12,773	-	
June .....	55,449	69,885	17,757	19,275	-	
July .....	54,789	50,617	21,291	19,797	-	
August ...	43,395	34,065	15,734	8,021	-	
September	35,496	38,069	9,509	3,408	86	
October ..	44,291	35,935	15,570	5,633	2,158	
November .	15,422	33,873	-	-	-	
December .	-	2,001	-	-	-	
Totals	2,022,703	2,285,411	1,286,738	512,976	63,486	71,749

Note: In June, 1919, Shovel #6 (Electric) was moved to the Power House site and the Queenston-Power House Railway.

E.S. #1 denotes Shovel #1, Electric.

S.S. #5 denotes Shovel #5, Steam.



Canal Excavation Onlymonth by month, by the several Excavating Units (Continued)

S.S. #7	S.S. #8	S.S. #9	S.S. #10	S.S. #11	S.S. #12	S.S. #14	Misc. Equip.
20,945 ...	47,543 ...	11,173 ...	9,755 .....				3,941
22,700 ...	74,470 ...	12,267 ...	8,707 .....				8,449
39,285 ...	77,904 ...	15,094 ...	- .....				13,278
48,670 ...	40,249 ...	60,361 ...	- .....				6,310
21,952 ...	70,863 ...	45,418 ...	- .....				8,047
- ...	75,021 ...	24,929 ...	- .....				150
- ...	40,021 ...	12,632 ...	- .....				-
8,427 ..	124,468 ...	75,533 ...	8,634 .....				9,554
71,438 ..	161,601 ...	41,728 ...	17,218 .....				-
57,475 ..	121,750 ...	24,107 ...	13,472 ...	38,810 .....			-
56,317 ...	78,272 ...	23,259 ...	6,684 ..	100,028 ...	2,000 ...	1,552 ..	-
43,433 ...	90,596 ...	16,588 ...	10,189 ...	79,939 ...	75,150 ...	-	5,147
42,304 ..	122,966 ...	23,230 ...	9,922 ...	87,210 ...	85,869 ...	14,525 ..	2,028
32,741 ...	46,304 ...	35,713 ...	9,473 ..	148,968 ..	108,695 ...	29,464 ..	-
21,536 ...	56,217 ...	28,613 ...	6,667 ..	128,467 ..	121,931 ...	35,732 ..	4,068
9,327 ...	69,069 ...	25,400 ...	20,111 ..	135,533 ..	137,854 ...	26,985 ..	7,116
3,612 ...	65,197 ...	25,551 ...	7,685 ..	158,036 ..	69,835 ...	32,311 ..	10,312
11,897 ...	46,475 ...	25,379 ...	- ..	186,310 ..	50,545 ...	22,773 ..	6,946
7,234 ...	55,647 ...	48,784 ...	- ..	25,380 ..	38,369 ...	62,916 ..	14,749
5,045 ...	33,385 ...	51,581 ...	- ..	31,850 ..	17,614 ...	16,713 ..	10,050
5,250 ...	27,021 ...	57,436 ...	- ..	35,795 ..	24,983 ...	-	6,892
- ...	39,724 ...	-	- ..	35,798 ..	38,808 ...	-	24,593
- ...	32,290 ...	-	- ..	46,146 ..	31,457 ...	-	19,671
- ...	-	-	- ..	1,549 ..	4,136 ...	-	3,523
93,158	2,340,948	1,198,817	152,130	1,259,819	807,240	242,971	234,393



[illegible][illegible]

200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

Queenston-Chippawa Development - Canal Excavation Only

Table showing Quantities of Earth and rock Excavated, year by year,  
by the several Excavating Units

	1917	1918	1919	1920	1921	Total
	Cu.Yds.	Cu.Yds.	Cu.Yds.	Cu.Yds.	Cu.Yds.	Cu.Yds.
<u>Shovel No. 1.</u>						
Earth .....		538,595	348,727	.....		887,322
Rock .....			4,960	673,627	483,794	1,165,381
<u>Shovel No. 2.</u>						
Earth .....		247,665	740,735	409,323	.....	1,397,723
Rock .....			143,627	177,226	566,830	887,683
<u>Shovel No. 3.</u>						
Earth .....	9,236	179,627	243,033	591,722	127,037	1,149,655
Rock .....		20,864	19,171	6,200	90,848	137,083
<u>Shovel No. 4.</u>						
Earth .....		55,161	11,383	110,859	96,714	273,117
Rock .....		55,703	39,515	.....	84,641	239,859
<u>Shovel No. 5.</u>						
Earth .....	10,857	15,892	8,451	7,211	6,901	49,312
Rock .....		409	.....	10,842	2,923	14,174
<u>Shovel No. 6.</u>						
Earth .....	3,393	42,427	25,929	.....	.....	71,749
Rock .....						
<u>Shovel No. 7.</u>						
Earth.....	109,519	22,084	227,317	390,642	103,697	853,259
Rock .....		3,270	1,380	.....	35,249	39,899
<u>Shovel No. 8.</u>						
Earth .....			743,925	1,002,738	129,759	1,876,422
Rock .....					464,526	464,526
<u>Shovel No. 9.</u>						
Earth .....			501,293	239,169	157,801	898,263
Rock .....			12,756	123,912	163,886	300,554
<u>Shovel No.10.</u>						
Earth .....			26,433	71,639	54,058	152,130
Rock .....						
<u>Shovel No.11.</u>						
Earth .....				218,777	830,992	1,049,769
Rock .....					210,050	210,050
<u>Shovel No.12.</u>						
Earth .....				77,150	519,563	596,713
Rock .....					210,527	210,527
<u>Shovel No.14.</u>						
Earth .....				1,552	241,419	242,971
Rock .....						
<u>Miscellaneous Equipment</u>						
Earth .....	3,992	1,508	48,104	54,176	33,004	140,784
Rock .....	10	558	15,199	700	77,144	93,609





Continued on

COPY

Queenston-Chippawa Power DevelopmentTable showing Daily Average Quantity of Earth and Rock Excavated.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	E.S. #5	E.S. #6
<u>1917:</u>						
May .....						
June .....						
July .....						
August .....					560	
September .....					40	
October .....					202	
November .....					421	111
December .....			659		-	310
<u>1918:</u>						
January .....			1,141	435	292	144
February .....			1,146	700	-	401
March .....	638		1,266	451	-	-
April .....	1,647		3,080	810	-	23
May .....	1,645	2,238	-	496	-	122
June .....	3,334	3,321	519	430	331	301
July .....	3,094	-	1,078	-	248	302
August .....	4,129	1,757	546	193	287	118
September .....	766	2,304	720	-	126	247
October .....	2,284	2,913	959	632	-	361
November .....	2,753	1,403	-	905	-	125
December .....	1,995	1,880	2,678	905	-	103
<u>1919:</u>						
January .....	2,301	1,933	1,155	1,012	510	-
February .....	1,935	3,239	921	685	-	377
March .....	2,369	2,410	189	-	292	195
April .....	2,643	1,943	150	-	-	286
May .....	-	1,285	858	-	-	303
June .....	-	2,098	435	202	-	100
July .....	-	2,032	-	1,144	445	-
August .....	-	1,549	626	319	269	-
September .....	-	518	432	334	-	-



Canal Excavation Onlymonth by month, by the several Excavating Units

S.S. #7	E.S. #8	E.S. #9	S.S.#10	S.S.#11	S.S.#12	S.S.#14
---------	---------	---------	---------	---------	---------	---------

546						
804						
666						
786						
1,188						
584						
666						
660						

-						
-						
-						
-						
-						
-						
-						
1,107						
623						
457						
-						
-						

460						
-						
-						
-						
-		167				
-	1,120	-				
-	1,655	1,757	73			
224	2,662	1,793	237			
1,634	3,516	2,511	84			
1,160	2,030	1,525	218			

C.O.P.Y.



一、基本案情：2015年12月，被告人王某在北京市某小区内，将被害人李某的电动自行车一辆，价值人民币1500元，盗走。王某在盗取过程中，被小区保安发现并制止，王某随即逃跑。王某在逃跑过程中，被保安追赶至小区门口，王某在逃跑过程中，将保安打伤，造成保安轻伤。王某在逃跑过程中，被保安追赶至小区门口，王某在逃跑过程中，将保安打伤，造成保安轻伤。王某在逃跑过程中，被保安追赶至小区门口，王某在逃跑过程中，将保安打伤，造成保安轻伤。

COPI

1. The first part of the document is a header section containing the following information:
 

- Page No. 1
- Date: 10/10/2019
- Page No. 1

2. The second part of the document is a table with the following columns:
 

Sl. No.	Name of the Candidate	Grade	Percentage
1	ABHIRAM K	10	100
2	ADARSH K	10	100
3	ADITHYAN K	10	100
4	ADITHYAN K	10	100
5	ADITHYAN K	10	100
6	ADITHYAN K	10	100
7	ADITHYAN K	10	100
8	ADITHYAN K	10	100
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Queenston-Chippewa Power DevelopmentTable showing Daily Average Quantity of Earth and Rock Excavated.

	E.S. #1	E.S. #2	E.S. #3	E.S. #4	S.S. #5	E.S. #6
<u>1919</u> (continued,						
October .....	-	627	1,148	-	-	-
November .....	-	721	1,837	-	243	-
December .....	451	897	1,163	-	181	-
<u>1920:</u>						
January ...	1,235	686	885	-	196	-
February ..	1,142	914	1,519	-	774	-
March .....	1,311	250	459	-	-	-
April .....	1,328	2,236	1,108	-	-	-
May .....	995	1,857	1,841	-	-	-
June .....	1,226	-	908	-	-	-
July .....	639	1,111	932	-	78	-
August ....	1,255	2,189	1,743	-	70	-
September .	1,372	1,721	1,943	-	138	-
October ...	1,548	1,737	1,486	-	189	-
November ..	1,327	865	1,124	1,207	-	-
December ....	807	1,001	803	1,068	-	-
<u>1921:</u>						
January ...	1,541	985	962	1,500	-	-
February ....	820	1,088	1,239	633	217	-
March .....	1,315	1,118	1,086	225	38	-
April .....	1,164	1,516	241	173	-	-
May .....	1,022	1,348	337	261	-	-
June .....	973	1,456	555	459	-	-
July .....	1,054	1,059	444	430	-	-
August ....	1,173	971	629	573	-	-
September ...	887	929	453	227	17	-
October ...	1,055	1,198	1,298	282	154	-
November ..	1,714	753	-	-	-	-

Note: In June, 1919, Shovel #6 (Electric) was moved to the Power House site and the Queenston-Power House Railway.

E.S. #1 denotes Shovel #1, Electric.

S.S. #5 denotes Shovel #5, Steam.



Canal Excavation Onlymonth by month, by the several Excavating Units (Continued)

S.S. #7	E.S. #8	E.S. #9	S.S. #10	S.S. #11	S.S. #12	S.S. #14
1,032	2,053	1,467	70			
935	2,774	1,541	157			
595	1,224	357	194			
403	880	294	199			
597	1,959	361	238			
755	1,855	314	-			
1,106	1,059	1,207	-			
878	1,417	1,376	-			
-	2,885	1,917	-			
-	1,334	601	-			
444	2,394	1,481	132			
1,520	3,108	852	383			
1,197	2,590	541	306	1,021		
1,149	1,779	447	171	1,924	200	172
905	1,776	325	216	1,859	1,503	-
881	2,510	474	331	1,982	1,717	454
799	945	744	211	3,194	2,218	670
653	1,004	530	190	2,424	2,217	701
187	1,354	498	394	2,711	2,506	529
903	1,304	511	607	3,099	1,369	621
-	894	529	-	3,881	903	393
-	959	976	-	552	711	1,165
-	1,012	1,359	-	861	1,036	1,671
-	819	1,511	-	1,023	543	-
-	923	-	-	688	761	-
-	1,153	-	-	982	684	-

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Algenston-Gaipawa Power DevelopmentSummary of Information regarding Excavating  
Units for Total Excavation Work in  
the Dry

Unit No.	Motive Power	Date Received	Earth Excavated	Rock Excavated
1	Electric	Dec. 25th, 1917	859,345	1,519,175
2	Electric	Dec. 25th, 1917	1,487,230	887,683
3	Electric	Nov. 30th, 1917	1,279,088	157,923
4	Electric	Dec. 11th, 1917	356,849	572,651
5	Steam	May 27th, 1917	169,628	14,174
6	Electric	Nov. 3rd, 1917	118,542	60,167
7	Steam	May 3rd, 1917	914,857	83,597
8	Electric	Mar. 31st, 1919	1,876,422	464,526
9	Electric	Mar. 31st, 1919	1,011,840	300,554
10	Steam	June 14th, 1919	171,604	-
11	Steam	Sept. 9th, 1920	1,049,769	210,407
12	Steam	Nov. 9th, 1920	596,713	210,527
13	Steam Ditcher	Oct. 14th, 1920	16,484	-
14	Steam	Nov. 1st, 1920	248,843	-
Miscellaneous			265,506	181,544
Totals			10,422,620	4,662,928
Additional quantities from final estimate, not distributed to units			42,363	77,031
Total Cubic Yards			10,464,983	4,739,959





Sub-aqueous Excavation.

The rock line intersected the grade line of the floor of the Canal about a mile from the Welland River at the Montrose end. More precisely, the rock surface intersected the grade line of the floor of the Canal at Station 47+00 and rose on a slope of about one in thirty in the northerly direction. The excavation down to about Station 55 was therefore taken out as sub-aqueous work after the upper part, averaging about 20 feet in depth, had been removed by the dry-excavation equipment. Water was admitted from the Welland River through a by-pass canal paralleling the Michigan Central Railroad tracks and about 300 feet northerly therefrom. A suction dredge was then used to remove the earth in the Canal down to a flat bottom averaging Elevation 538. The yardage removed by the dredge amounted to approximately 1,100,000 cubic yards.

The manner of making the excavation may be clearly seen by reference to photograph No. H-78 which shows the "Cyclone" in operation shortly before it completed its task. At this time the dredge was within about one hundred yards of the portion of the Canal that had been excavated in the dry.

The dredge discharged the material on disposal areas located on the westerly side of the Canal, the location of which may be seen by reference to the plan of the disposal areas shown on page H-84 in the part of Chapter H on Construction Plant for Transportation.

The dredge operated for 204 working days between December 10th, 1920, and September 3rd, 1921.







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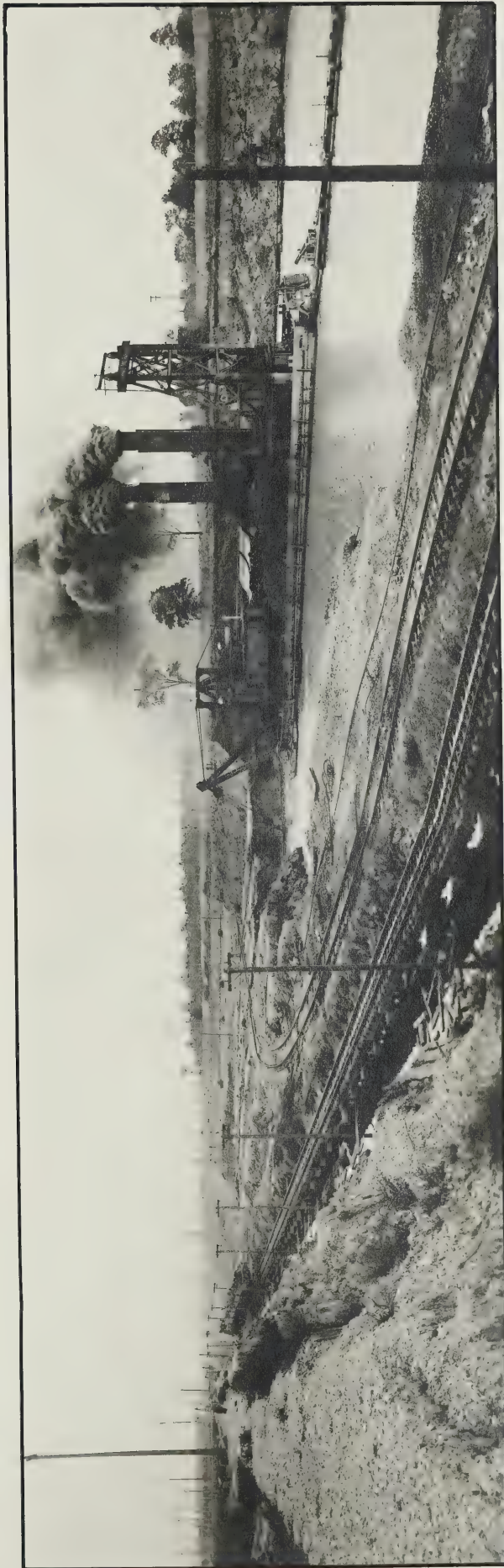
To face page H-148

No. H-78

Photograph showing

Dredge "Cyclone" in Operation at Station 49.

Taken August 30th, 1921.







The details of the dredge "Cyclone" may be appreciated by reference to photographs Nos. H-79 and H-80 on page H-150 hereof, the former picture showing a side elevation of the dredge together with its "A" frame and deck arrangements, and the latter showing the boom and the cutter raised out of the water.

The rated capacity of the dredge was stated by the Toronto Harbour Commissioners to be not more than 4,000 cubic yards per day of 24 hours in material of the nature encountered. The boiler capacity of the dredge was 1,200 horse-power, and the coal consumption about 30 tons of bituminous coal per twenty-hour day. The discharge pipe of the dredge was 24 inches in diameter.

COPY

The "Cyclone" was not purchased by the Hydro-Electric Power Commission but was rented from the Toronto Harbour Commissioners for a total lump sum price of \$250,000. By the terms of the contract the Harbour Commissioners delivered the "Cyclone" to the Hydro-Electric Power Commission at Toronto on the 29th day of November, 1920, complete with all equipment, and the Hydro-Electric Power Commission agreed to return the dredge with its equipment, complete in all respects and in condition similar to that when received, to the Harbour Commissioners on or before the 15th day of September, 1921. In addition, the Hydro-Electric Power Commission undertook to insure the dredge and its equipment against fire and marine risks in the sum of \$1,000,000, and the pontoons accompanying it in the sum of \$100,000, the Hydro-Electric Power Commission to bear the cost of the premiums. By a supplementary agreement, the Hydro-Electric Power Commission undertook to pay the Harbour Commissioners \$350,000 in case of loss of the dredge on the trip to and from Chippawa in lieu

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To face page H-150

No. H-79

Photograph showing

Side View of the Dredge "Cyclone".

Taken December 13th, 1920.

COPY

No. H-80

Photograph showing

"A" Frame, Boom and Cutter of Dredge "Cyclone".

Taken February 1st, 1921.







of providing the before-mentioned insurance. There were other conditions in the way of penalties and so forth, but they were not called into action because the Hydro-Electric Power Commission was able to fulfil its part of the agreement and the "Cyclone" after finishing its work on September 3rd, 1921, was duly returned to the Toronto Harbour Commissioners at Toronto.

In taking the dredge from Toronto to Chippawa, the Hydro-Electric Power Commission took the risks incident to the lateness of the season, and succeeded in delivering the dredge into the Welland River almost the exact day of the close of navigation. After arriving, it had to be repaired and made ready, and the disposal areas had to be prepared. The actual excavation was commenced on March 14th, 1921. The progress made by the dredge "Cyclone" was as follows:

<u>Date</u>	<u>Quantity</u>
March, 1921 .....	124,970 cubic yards
April, 1921 .....	157,349 cubic yards
May, 1921 .....	166,541 cubic yards
June, 1921 .....	209,802 cubic yards
July, 1921 .....	212,359 cubic yards
August, 1921 .....	157,973 cubic yards
Sept. 1921 .....	<u>57,239 cubic yards</u>
Total .....	<u>1,086,233 cubic yards</u>

On the completion of the excavation by the dredge "Cyclone" the Hydro-Electric Power Commission entered into a contract with John E. Russell for the excavation of 30,000 cubic yards of sub-aqueous earth work at the junction between the Welland River and the entrance to the Canal, and at the commencement of the rock section, at a price of 70 cents per cubic yard. The work was done by Mr. Russell with the dredge "Niagara" (since called the "Hennessy"), a suction dredge with a 14-inch discharge pipe. Mr. Russell provided his





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own plant for the work, and the Hydro-Electric Power Commission acquired no right of proprietorship therein.

*Walter J. Francis*

Consulting Engineer.

Toronto, March 21st, 1923.

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• 1900-1901 1902-1903













